The Limits of Young Children's Understanding of Sources of Knowledge

by

Gillian Margaret Waters

A thesis submitted to

The University of Birmingham

for the degree of

DOCTOR OF PHILOSOPHY

School of Psychology

The University of Birmingham

May 2009

Abstract

Seven experiments determined whether young children's comprehension of aspectuality, when acquired, was robust enough to cope with demands and variations to the task. Four to 5-year-olds were able to choose whether to look or feel to find out information about a hidden item that was identifiable by sight or touch (Experiments 2 & 7). However, they had difficulty when the test question did not directly refer to a perceptual aspect of the target item (Experiment 7). Four to 6-year-olds coped well with irrelevant verbal descriptions of the items included in the test question (Experiments 2 & 3). Five and 6-year-old's performed well whether the target had to be discovered or located (Experiment 1) but had difficulty when irrelevant partially differentiating information was included in the array of items (Experiments 3 & 4) and when they received verbal pre-trial experience of the items (Experiments 5 & 6). In conclusion, children depended on their recall of their pre-trial experience of the items, even when it was unnecessary to do so. They had difficulty recognizing the relevance of verbal information and problems recalling it. Hence, their understanding of sources of knowledge is limited until at least 7 years of age.

Dedication

I dedicate this thesis to my beautiful son Theo: His arrival into this world might have somewhat delayed its completion, but he was worth it!

Acknowledgements

First, I would like to thank Sarah Beck for her truly excellent supervision, support, and friendship. I feel extremely fortunate to have been her first PhD student. Thank you also to the School of Psychology at the University of Birmingham for funding me throughout this research and to the Institute for Psychological Sciences at the University of Leeds for giving me a desk and computer to use during the latter half of my PhD studies. The research itself would not have been possible without the assistance of the teachers and pupils at the following primary schools in Birmingham: Cotteridge; Hall Green; St Edward's RC; Billesley; Cottesbrooke; Hollywood; St Brigid's RC; St Laurence Church; Anderton Park. Also, Woodhouse West School in Sheffield and Moor Allerton Hall, Holy Family RC, St Augustine's RC and Iveson Primary Schools in Leeds.

I would like to thank Ian Apperly for always coming up with useful comments! Also, thanks to Liz Robinson for her continued interest in my research and to the (then) members of the Cognitive Development team at the University of Birmingham for their encouragement and support: Dan Carroll, Elisa Back, & Sarah Gorniak. A huge thank you to Katie Judge for the last minute proof reading – what a star! Thank you to my Mum and Dad and the rest of my family for believing in me and to my friends for being so patient and listening to me spout on about my research. In particular Maria Parker, Louisa Horner, Pat & Tricia Bolt, and more recently, Donna Hasyn, Maeve Curran, Laura Viner, & Mags Portman.

Finally, and most importantly, I would like to thank my partner Russ. He has always been my inspiration and has constantly had faith in my ability. Without his support none of this would have been possible.

Contents

List of Tables

List of Figures

CHAPTER 1 – INTRODUCTION AND LITERATURE REVIEW

Do you know where your car keys are? Yes? How do you know? Maybe you know that your keys are in your bag because you remember putting them in there earlier today. Or maybe you know they are in your bag because you can see them poking out, even if you cannot recall actually placing them there. Knowing *that* you know something and understanding *how* you have come to know it are important skills that enable us to comprehend our world. They are metacognitive abilities, in that they entail thinking about what we know. When we think about our knowledge states we show awareness of the cognitive processes involved (Flavell, 1976, 1979). This level of thinking allows us to actively process the knowledge that we possess: We are able to evaluate it, justify it and disregard it, if required (Gopnik & Graf, 1988; O'Neill & Gopnik, 1991).

In our day-to-day lives we demonstrate our awareness of our knowledge states. We evaluate what we know by assessing where it has come from. We consider the source of our knowledge to justify its validity or establish its unreliability. For example, imagine a friend asks you to meet them in a café. You know where you have to meet them because they gave you directions and you trust that they were correct. You believe the source of your knowledge. In contrast, if a stranger had given you directions to this café, you may not be confident about this source of information and may check that they were correct. Hence, we alter the way we behave depending on our evaluation of our knowledge sources (Tardif, Wellman, Fung, Liu, & Fang, 2005).

Young children are constantly being told or shown new pieces of information, for example, how a toy works, or where an item has been placed. Once children are in possession of this information, they may simply accept what they have just learned. On the other hand, they may judge whether or not they should believe it. Children may make these judgements for many reasons: They must understand whether or not they should trust the sources of their knowledge, so they can learn to function effectively in the world (Perner, 1991); They need to be able to assess the truth of what they have been told, so they can learn from other people's experiences (e.g., Robinson, Champion, & Mitchell, 1999; Robinson, Haigh, & Nurmsoo, 2008); They need to understand that knowledge is based on evidence, as this is important for justification of validity and scientific thinking (e.g., Pillow, Hill, Boyce, & Stein, 2000); They need to be able to judge whether or not others share their knowledge, as this forms the basis for most social interactions (e.g., Gopnik & Astington, 1988; Hogrefe, Wimmer, & Perner, 1986; Perner, Leekham, & Wimmer, 1987; Wimmer & Perner, 1983).

It seems, therefore, that young children's ability to understand the sources of their knowledge is important for the development of both their cognitive and social functions (e.g., Gopnik & Graf, 1988). Prior research reflects this significance. Over the past twenty-five years, researchers have investigated the relationship between young children's understanding of sources of knowledge and other cognitive abilities such as Theory of Mind (ToM), memory, and language (see Naito, 2003; Perner & Ruffman, 1995, for examples). Previous studies have also tracked the development of young children's understanding of knowledge sources. For example, research has found that while 3-year-olds show limited comprehension of where their knowledge has come from (e.g., O'Neill & Gopnik, 1991), by the ages of 5 or 6 years young children have the ability to assess both how knowledge has been acquired and how it can be gained in the future (e.g., O'Neill, Astington, & Flavell, 1992).

Nevertheless, much of young children's understanding of the importance of knowledge sources remains unexplored. For example, we know little about how robust their comprehension actually is. Once they show understanding of where their knowledge has come from are they then able to cope well with different formats, presentations, or variations in those sources? Once they grasp the concept of how they can gain knowledge is their understanding complete, or are they vulnerable to unexpected demands, changes, or contexts? The focus of this thesis is this: the limits of young children's understanding of sources of knowledge.

The following literature review will evaluate the research that has been carried out on 3 to 7-year-old children's understanding of sources of knowledge and related areas. Initially the review will explore how understanding sources of knowledge is associated with the broader metacognitive abilities linked with possession of a ToM. This will be followed by reviews of the literature investigating: how young children come to understand the meaning of knowledge; their comprehension of the link between perception and knowledge states; their ability to reflect on how knowledge has been acquired; and their active use of knowledge. The final section will focus on the development of aspectuality: how young children come to understand the necessary perceptual action to find out specific knowledge from a source.

1. Theory of Mind and Sources of Knowledge

Someone is said to possess a ToM if they are able to attribute mental states to themselves and others (Wimmer & Perner, 1983). For example, you have a ToM if you understand that another person may not be thinking about the same thing that you are (Marvin, Greenberg, & Mossler, 1976). Research into the development of ToM in young children has tended to focus on mental states such as beliefs, knowledge, desires and intentions (Flavell, 2000). The aims of this type of research are to discover what young children understand about mental states and how much they understand about the causal links between these mental states, perception, and behaviour. The interest here is how someone with a ToM must understand *whether* possession of knowledge exists and *what justification* there is for that knowledge state. A summary of the tasks that tend to be used to assess ToM will now follow.

ToM is rooted in the idea that young children are egocentric (e.g., Piaget & Inhelder, 1956). In other words, young children have difficulty in imagining perspectives other than their own; they tend to be biased towards their own point of view. Therefore, ToM in children tends to be assessed by asking them first, what they are thinking, and second, what another person might be thinking (e.g., Wimmer & Perner, 1983). For example, in a “deceptive box" task, 3 to 5-year-old children are shown a “Smarties” box (Perner, Leekham, & Wimmer, 1987). They are asked what they think is inside the box and they tend to reply that it contains Smarties. The experimenter then opens the box and demonstrates that there are actually pencils inside. The box is closed and (crucially) children are asked what another child would think it contained if they now entered the room. Most 4 and 5-year-olds pass this task and realise that a child entering the room will think what they had originally thought; that the box contained Smarties. However, most 3-year-olds state that a child entering the room will know that the box contains pencils. These 3-year-olds do not see the situation from another’s perspective; they act as though the other child has their knowledge state. They do not evaluate the evidence for the other child’s knowledge state. They do not realise that the other child does not know what they know (the true contents of the box).

Young children’s understanding of ToM is also often assessed with a “false belief” task. False belief refers to the understanding that others can have beliefs about the world that are incorrect. The false belief task indicates a robust ToM and an understanding of the need for evidence to support knowledge (Perner, 1991; Wellman, 1990). The classic false belief “unexpected transfer” task, designed by Wimmer and Perner (1983), involves a child observing two dolls (Sally and Anne) playing with a marble. The dolls put the marble into a box, then Sally leaves while Anne stays with the box. While Sally is away Anne moves the marble from the box to a basket. When Sally returns the child is asked where she (Sally) will look for her marble. To pass the task the child must state that Sally will look for the marble where she left it (in the box) and not where it actually is (in the basket). Until the age of 4 years children have difficulty with this task. They do not evaluate the evidence for Sally’s knowledge state. They do not realise that she does not know what they know (the true location of the marble).

One difficulty with ToM tasks is that very young children often lack the ability to understand verbal instructions and offer verbal responses. When verbal responses are unsuitable, preferential looking times can be taken as a measure of interest and understanding. Onishi and Baillargeon (2005) devised a non-verbal unexpected transfer task in which 15-month-old infants watched a sequence of events unfold. They watched an actor looking at a toy being placed in a box. The toy was then transferred to another box without the actor seeing. The task then required the actor to retrieve the toy. The infants looked longer when the actor behaved unexpectedly. In other words, when the actor reached for the box where the toy actually was, rather than the box where she had seen the toy being placed, it attracted the infant's attention. This demonstrated that the infants had awareness of the actor's knowledge state, even though it was different from their own. They understood where the actor should look (based on her knowledge state), and noticed when her behaviour did not reflect that knowledge state.

Young children's non-verbal responses to false belief tasks have also been examined by Clements and Perner (1994) and Garnham and Ruffman (2001). Although the 2 to 3-year-olds they tested gave incorrect verbal responses to the task (they said that the actor would look for the item in its new location), their eye gaze indicated otherwise (that the actor would look for the item in its old location). This anticipatory looking behaviour suggested that children did realise that the actor's belief was different to theirs, but had difficulty verbalising that understanding. Their explicit response was different to their implicit response. In other words, they showed implicit understanding of belief.

So, existing research has assessed young children's explicit and implicit understanding of ToM. However, regardless of what is being assessed, both types of understanding rely on the understanding of sources of knowledge. In order to understand what another person (or doll) believes, young children must think about the cause of that belief. They must evaluate the evidence for, and source of, that knowledge. This is how understanding sources of knowledge can be related to possession of a ToM. Indeed, Burr and Hofer (2002) suggest that tasks assessing understanding of sources of knowledge were devised to find out why children who fail the false belief task did not seem to think about the other person's perspective. In tasks investigating understanding of sources of knowledge young children have to evaluate what knowledge they or others possess or need, and what perceptual access they and others have had, or could have (e.g., Gopnik & Graf, 1988; O'Neill et al., 1992; O'Neill & Gopnik, 1991).

Children begin accurately (and explicitly) reporting the sources of their knowledge from 3 to 4 years of age (e.g., Gopnik & Graf, 1988), around the same time as they can pass explicit ToM tasks (e.g., Wimmer & Perner, 1983). Their ToM ability appears to be dependent on their capacity to understand sources of knowledge. This is because in order to understand *what* someone else might be thinking, you have to realise *why* they might have that belief. For example, in order to understand that Sally will think that the marble is where she left it, you have to realise that she did not *see* it being moved (Wimmer & Perner, 1983). Children need not only to be aware of other people's sources of knowledge, but they also have to understand how these sources form evidence and justification for knowledge states. From this, it seems that understanding sources of knowledge is not only *associated* with possession of ToM, but may be a *precursor* for ToM.

Understanding sources of knowledge and possessing a ToM are also associated with other developments in young children's cognitive abilities. Perner (1990, 1991, 2000) suggests that episodic memory development is associated with children's ability to assess mental states. Episodic memory requires children to recall their experiences as having been personally experienced (knowing *how* you know) and is distinct from semantic memory which just requires knowing facts (knowing *that* you know) (Tulving, 1983, 1985). If young children must re-experience an event in order to realise *how* they know something, they must be simultaneously considering the source of their knowledge (Perner, 1990). Therefore, understanding sources of knowledge may not only be important for the acquisition of a ToM but may also be dependent on episodic memory development (e.g., Perner & Ruffman, 1995).

In summary, the evidence presented so far suggests that young children's metacognitive abilities, specifically their possession of ToM, is related to their understanding of where knowledge comes from and their ability to evaluate this knowledge. To be able to understand sources of knowledge, young children must understand what constitutes knowledge itself. The next section of this literature review will focus on young children's comprehension of the meaning of knowledge.

2. Understanding the Meaning of Knowledge

How do young children come to understand what it means to "know" something? Perner (1991) proposed three facets of knowledge that must be comprehended before children can be said to have an understanding of knowledge states. First, they must realise that knowledge is associated with truth. For example, you can only "know" that an egg box contains eggs if the box actually does contain eggs and not something else. Second, children must comprehend that knowledge can be "proved" by acting successfully. For example, you can prove that you know which of three boxes contains eggs by opening the appropriate box and showing that there are eggs inside.

Nevertheless, not all realms of knowledge can be proved by such direct action. For example, we "know" that historical events have taken place because we have read about them, not because we have taken part in them. In this way, we trust the authors of the historical texts that we read. We realise the significance of the evidence they present and accept it as a substitution of direct personal proof. Consequently, Perner's (1991) third facet of knowledge concerns such verification of facts; young children must understand that knowledge must be supported by evidence. For example, that you will only know that the box actually contains eggs if you look, or if you are informed by a reliable source of knowledge.

At around 3 years of age, young children understand the first two aspects of knowledge, but it is only later that they understand the significance of sources of knowledge (Perner, 1991). In other words, 3-year-olds do not realise that knowledge is dependent on evidence. Instead, they believe that successful behaviour is a sign of having knowledge. For example, imagine someone choosing correctly the box that contains the eggs. Three-year-olds do not consider whether that person had based their decision on an accurate source of knowledge (e.g., they had been told which one to pick), or because they had no evidence (e.g., they made a lucky guess). They do not consider whether the person knew what was in the box because they had seen it, or someone had told them, or if they had no evidence at all and had chosen that box at random. Three-year-old children are only concerned with the fact that the person had successfully found the eggs.

According to Perner (1991), therefore, young children initially have a behavioural theory of knowledge. They believe that knowledge is demonstrated by successful action. This behavioural theory of knowledge has been supported by several pieces of research that show young children associating knowledge with success, rather than evidence. For example, 3-year-olds tend to attribute prior knowledge to a person who has found a hidden item by guessing (e.g., Johnson & Wellman, 1980). Young children also tend to view their own knowledge differently, depending on whether it is based on their physical behaviour, or not. For example, 4 and 5-year-olds admitted that they had learned new information when that information was behavioural (i.e., an action), but incorrectly stated that they had possessed prior knowledge of the new information when it was factual (Esbensen, Taylor, & Stoess, 1997). They acted as though only behavioural knowledge was important.

Young children’s understanding of the false belief paradigm also seems associated with the behavioural theory of knowledge (Perner, 1991). As mentioned previously, false belief is typically demonstrated by asking children what someone else, who does not share their own knowledge state, is thinking (see Wimmer & Perner, 1983). Astington and Pelletier (1996) showed that children who passed false belief tasks (where they had to attribute an incorrect belief to another) referred to teaching as "telling". In other words, these children understood teaching as passing on knowledge verbally. However, children under 4 years of age who could not pass false belief tasks referred to teaching as "showing"; in this case, teaching was associated with action. Emphasis on behavioural knowledge acquisition is also evident in children’s performance on second order false belief tasks, where they have to explain what someone else, who does not share another’s knowledge state, is thinking. For example, 5-year-olds were found to have difficulty distinguishing between the behavioural action that caused a situation and someone’s belief about it (Astington, Pelletier, & Homer, 2002).

So far, this review has covered young children’s understanding of what the mental state of “knowing” means, but do young children understand what the word “know” actually signifies? They may use the word freely but not comprehend its true meaning.

They may not realise that it refers to such a definite mental state and this could be why they confuse it with other less certain terms. Several researchers have investigated young children's understanding of mental state words. For example, Moore, Bryant, and Furrow (1989) examined 3 to 8-year-olds ability to distinguish between the terms "knowing", "thinking", and "guessing". A piece of candy was hidden in one of two boxes and two monkeys 'informed' children of its location. One monkey would state that it *knew* where the candy was hidden, while the other would say that it could *guess* where it was, or that it *thought* the candy was in a particular box (or different combinations of the terms knowing, guessing and thinking). The results showed that 4-year-olds could differentiate between knowing, thinking and guessing; they successfully picked the box indicted by the most definite term. They showed more confidence in the monkey who *knew* than the monkey who *guessed,* and in the monkey who *knew* than the monkey who *thought*, but realised that *guessing* and *thinking* were equivalent. These findings indicate that 4-year-olds have awareness of the certainty of these knowledge state descriptions.

Other research suggests that it is not until at least 5 years of age, that young children understand the difference between knowledge and other mental states such as guessing. For example, Johnson and Wellman (1980) proposed that young children do not understand that knowledge requires evidence because they are unable to say how they have come to possess information. In their study, an item was hidden in one of two boxes. Four to 9-year-olds were either: shown where the item was before the boxes were closed; could see where the item was because of clear windows in one side of the boxes; or had no idea in which box the item was hidden. Children were then asked which box the item was hidden in and had to justify their choice. Until the age of 6 years, children had difficulty reporting whether they had remembered, had known, or had guessed the location of the item. They were confused about the source of their knowledge. They did not seem to understand that knowing and remembering are based on evidence, but that guessing is not.

A similar task was carried out where children either saw an item being hidden in one of three boxes, or did not see it (Miscione, Marvin, O'Brien, & Greenberg, 1978). Children were asked to choose the box that was hiding the item. Children were then asked, *before and after* the items location was revealed, whether they had known or guessed where it was. After 5 years of age children were able to distinguish the differences between knowing and guessing. However, children between the ages of 4 and 5 years were more likely to base their responses on the outcome of the task, supporting Perner's (1991) behavioural theory of knowledge. For example, if children were shown that they had chosen the correct box, they were more likely to say that they had known where the item was, even if they had not seen the item being hidden and must have been guessing (Miscione et al., 1978). Even when they had accidentally been successful, children reasoned that they had known where the item was all along.

In summary, young children gradually come to comprehend the meaning of knowledge both as a mental state and as a mental state term. Understanding sources of knowledge appears to be a final acquisition in the development of understanding what knowledge means. Young children treat knowledge as something that is true and as something that can be proven, before they comprehend that it must also be justified by evidence (Perner, 1991). Young children initially believe that successful outcomes indicate possession of knowledge, before they understand the significance of evidence. However, understanding that knowledge requires evidence is not a straightforward process. Evidence can take several forms; it can be direct, through perceptual contact, or it can be indirect, through inference. The next section will summarise young children's understanding of perceptual access as a source of knowledge.

3. Understanding the Link Between Knowledge and Perception

As adults we understand that we can gain knowledge through the information transmitted by our senses. We realise that perception leads to knowledge, for example, that looking leads to knowledge of colour, whereas knowledge of weight can be gained by touching. We also comprehend that if we know that something is true we must have either had direct perceptual experience of it, or we trust the information we have been given from an indirect source. For example, you might know that my pet dog is black because you have *seen* it with your own eyes, or I might have *shown* you a photo of it, or *told* you its colour. On the other hand, you may have *inferred* that it is a black dog because of a clue; I might have mentioned that my dog's hair does not show up on my black coat.

At first, however, young children's understanding of the link between perception and knowledge is more limited. They do not realise that knowledge can be gained through a variety of perceptual sources. Rather, young children initially believe that seeing equals knowing (Dretske, 1969). Wimmer, Hogrefe, and Sodian (1988) suggest that when children have to assess someone's knowledge of an item, all they consider is whether or not that person has had visual contact with that item. If the person has seen the item, then the child attributes knowledge to them, if they have not, then the child believes them to be ignorant. For example, 3 and 4-year-olds attributed knowledge to someone who had seen a hidden item, but ignorance to someone who had had no direct perceptual contact, but had been told of its identity (Pillow, 1989; Pratt & Bryant, 1990; Wimmer, Hogrefe, & Perner, 1988; Woolley & Wellman, 1993). The children did not understand that, in both cases, knowledge would have been acquired.

Some studies have shown, however, that young children do not always rigidly follow the seeing equals knowing rule. They sometimes fail to attribute knowledge to someone who has looked. For example, Friedman, Griffin, Brownell, and Winner (2003) suggested that if children believed that seeing equals knowing then they would attribute knowledge in a "true belief" task. However, they found that 3 to 5-year-olds denied that a puppet would know where a toy had been hidden, despite having observed the puppet clearly ”seeing" the toy be placed in its original location and then moved to its final location. The children did not equate the puppet's visual access with knowledge: they behaved as if no "rule" exists between perceptual access and knowledge. To Friedman et al. (2003) this is just one demonstration of the fragility of young children's understanding of knowledge states.

Even if children do believe the seeing equals knowing rule, this does not necessarily mean that they understand exactly what can be learned from looking at an item. They may not grasp that seeing does not always lead to the acquisition of knowledge. Taylor (1988) suggests that while 4-year-olds realise that others may not know what they know (Level 1 conceptual perspective taking), it is not until several years later that they comprehend that seeing a small part of an item may not be enough to allow it to be identified (Level 2 conceptual perspective taking). For example, 5 to 7-year-olds maintained that they could successfully identify a picture, when in fact they had seen only a tiny, uninformative section of it (Robinson & Robinson, 1982). In this case, the children acted as though any type of visual contact was enough to provide full knowledge of the mainly hidden item. However, such overestimation of knowledge by children of this age is not unusual: they tend to misjudge what information they can acquire from other perceptual actions too. For example, they overestimate the knowledge that can be gained from ambiguous verbal information (e.g., Beck & Robinson, 2001).

Young children's tendency to overestimate knowledge acquisition and believe that seeing equals knowing implies that, at first, they do not understand indirect knowledge sources, such as inference. Evidence does suggest that understanding inference is a later acquisition than understanding more direct sources of knowledge. For example, Sodian and Wimmer (1987) carried out an experiment where children observed an actor looking at a container of identical balls. Out of sight of the actor one of these balls was then transferred to a bag. However, 4-year-olds refused to believe that the actor would know the colour of the ball in the bag. The children did not understand that because the actor knew that the ball had been taken from the container, he would be able to infer its colour. Being able to use inference as a source of knowledge is a valuable skill and yet Pillow, Hill, Boyce, and Stein (2000) among others, propose that it may not be until 8 years of age that children develop this ability.

The seeing equals knowing rule also implies that young children base knowledge only on visual access and may not believe that other perceptual experiences (e.g., feeling) are reliable sources of knowledge. O'Neill and Chong (2001) examined 3 and 4-year-olds' understanding of what knowledge could be gained from all five senses. In one of their studies children had to say how they had found out a particular perceptual property (e.g., a smell or a taste) and indicate the appropriate sensory organ on a toy. For example, smelling a bottle of bubble bath and pointing to the nose of a Mr Potato Head doll, rather than his eyes, ears, mouth, or hands. O'Neill and Chong's (2001) results indicated that young children suffer a general misunderstanding concerning the link between perceptual modalities and consequent knowledge, rather than behaving as though one type of perceptual act is best.

While young children's understanding of every perceptual action has been investigated, only certain types of access tend to be used when their understanding of sources of knowledge is being studied. These are seeing, feeling, and hearing. O'Neill and Gopnik (1991) support using these particular perceptual modalities because seeing and telling are important sources of knowledge from early in a child's life. They also suggest that from 3 years of age children seem to be able to reflect effectively on tactile experiences. For example, they perform well in appearance-reality tasks and perspective taking tasks involving tactile appearances (Flavell, Green, & Flavell, 1989). It is also possible that testing young children's understanding of taste and smell presents more methodological difficulties. For example, it is not always easy, or appropriate, to encourage young children to taste liquids that are unknown to them (O'Neill & Chong, 2001).

The three perceptual modalities of seeing, feeling, and hearing are not necessarily treated as equivalent sources of knowledge by young children. Biases towards particular modalities have often been found. For example, 4 to 9-year-olds frequently overestimated the amount of knowledge that they could acquire from looking (Robinson, Thomas, Parton, & Nye, 1997). However, despite the seeing equals knowing rule, children do not always show biases towards the visual mode of access. In one case, Flavell, Green, and Flavell (1989) found that the children they tested believed that feeling would give them all the perceptual information they needed (e.g., they acted as though feeling would inform them about an item's colour). Yet O'Neill and Gopnik (1991) did not find this bias towards feeling with a similar task. On the other hand, O'Neill et al. (1992) showed that young children prefer to feel when *they* are trying to find out information, but when assessing what *others* might know, they act as though those that are looking will gain more knowledge.

There is no explanation in the existing literature as to why young children show biases towards particular modalities when their understanding of sources of knowledge is tested. However, such preferences do appear to indicate a misunderstanding of the type of knowledge that can be gained by specific modes of access. As such, comparing children's understanding of at least two perceptual actions provides additional information about the limits of their comprehension of the knowledge that can be gained from different sources.

In summary, from around the age of 3 years children have some understanding (albeit with limitations) that perceptual access is important as a source of knowledge. However, children do not understand that knowledge can be gained through indirect sources, such as inference, until they reach 7 or 8 years of age. Realising that somebody possesses knowledge because of the perceptual experience they have had is an important development in understanding mental states. To comprehend what perceptual action had led to knowledge, young children have to be able to reflect back upon the source of that knowledge. The next section will summarise the research that has explored young children's understanding of how knowledge has been gained.

4. Reflections About Sources of Knowledge

This literature review has so far shown how young children's understanding of beliefs is associated with, and possibly relies upon, their understanding of knowledge sources. To comprehend why someone has a particular belief, young children must be able to reflect on the source of that person's knowledge. Also, in order to understand *their own* knowledge state, young children must be able to reflect on the source of *their own* knowledge. They must also realise when they do not possess knowledge and be able to reflect upon their lack of evidence as the cause for this knowledge state. Several researchers have investigated young children's ability to reflect upon sources of knowledge and say how information has, or has not, been gained. However, the literature offers a fairly inconclusive answer as to when young children fully understand this reflective process.

Some research has suggested that children might find it easier to judge the source of someone else's knowledge, rather than their own, because they are not distracted by performing the physical actions involved in such experiments (O'Neill et al., 2002). Therefore, children are often asked whether others are in possession of knowledge, and asked to justify this knowledge state. For example, Pillow (1989) asked 3-year-old children to say whether a doll that had looked in a box or a doll that had touched a box would know the colour of the toy inside. These children were able to say that only the doll who had looked would know the toy's colour. However, other researchers disagree and suggest that 3-year-olds have difficulty assessing what others know. Some of these studies have compared young children's ability to reflect on their own knowledge source with their ability to reflect on the source of someone else's knowledge. For example, Wimmer, Hogrefe, and Perner (1988) told or showed one child the contents of a box. Another child either shared the access or did not. The first child was asked whether they knew what was in the box and whether the other child knew what was in the box. Children aged 3 years had difficulty with the second part of this question. They were able to correctly say that they knew the contents of the box, but they could not correctly judge whether the other child knew or not. This happened even when the two children had shared the access, for example, when they had both looked into the box at the same time. Wimmer et al. (1988) concluded that 3-year-olds are able to assess their own knowledge states, but they cannot judge another person's beliefs on the basis of their access to sources of knowledge.

So, young children may be able to reflect upon their own knowledge states before they can reflect upon the knowledge states of others. It is likely that this is why the majority of the research investigating sources of knowledge has focused on this ability. However, rather than just asking children whether they possess knowledge (e.g., "do you know?") (Wimmer et al., 1988) other researchers have asked children how they have come to be in possession of knowledge (e.g., "how do you know?"). For example, in Gopnik and Graf's (1988) study children were shown, told, or inferred from a clue, the contents of a drawer. Children were asked how they knew what was in the drawer with a forced choice question, for example, "how do you know...did you see it, did I tell you about it, or did you figure it out from a clue?" Three-year-olds performed above what would be expected by chance at this task, although they did find it more difficult than the 4 and 5-year-olds tested.

In contrast, other research suggests that children around 3 years of age have difficulty saying how they have gained knowledge (e.g., O'Neill & Gopnik, 1991; Whitcombe & Robinson, 2000). In O'Neill and Gopnik's (1991) tasks, 3, 4, and 5-year-olds found out about an item that was hidden in a toy tunnel by seeing it, feeling it, or being told about it. They were asked to state what was in the tunnel and how they knew. Three-year-olds had difficulty with this task even after they had received training in identifying sources of information. O'Neill and Gopnik (1991) pointed out that children could have succeeded at the task by referring back to the event that had just taken place when answering the "how do you know?" question. They could have succeeded, even if they had no understanding of the significance of the evidence, by just recalling what perceptual action had just taken place. They could have just recalled looking, touching, or listening. However, the children did not do this. They seemed to treat the question "how do you know?" as something that they just could not answer.

It seems from the extant research, therefore, that while 3-year-olds can say *if* they know something, only when they reach around 4 years of age can they can consistently say *how* they know something (O'Neill & Gopnik, 1991; Whitcombe & Robinson, 2000). It also seems that young children can find it easier to judge their own knowledge states, than assess the knowledge states of others (Wimmer et al., 1988). Nevertheless, Pratt and Bryant (1990) have proposed that 3-year-olds must understand that knowledge can be gained by looking; in themselves and in others. This is because looking and knowledge are linked from a very young age: Even 1-year-old infants will follow an adult's gaze and attend to the same item in the environment (Scaife & Bruner, 1975). Pratt and Bryant (1990) also suggest that if a 3-year-old does not understand that information can be gained by looking, then looking at a picture book with a parent would be pointless as it would not allow shared conversation about the images.

To support their theory, Pratt and Bryant's (1990) research set out to show that difficult question phrasings were the cause of Wimmer et al.'s (1988) findings and that 3-

year-old children *did* understand that looking would lead to knowledge in another person, and not just themselves. Pratt and Bryant (1990) repeated Wimmer et al.'s (1988) experiments but simplified their test question. For example, Pratt and Bryant asked children "who knows what is in the box?" (p.976) rather than "Does.....know what is in the box or does she (he) not know that?" (Wimmer et al., 1988, p.388).

Pratt and Bryant's (1990) results showed that 3-year-olds could assess the knowledge of another when that knowledge was different from their own (also supporting Pillow's 1989 research). These 3-year-olds were able to do this when they were active participants in the task and when they were just observers. Altering the phrasing of the question allowed these children to perform well on this task and suggests that young children may be vulnerable to methodological differences in sources of knowledge tasks. This is a matter that will be broached later in this thesis; the influence of procedural differences on young children's performance.

To recap, the literature suggests that at around 3 years of age young children can say how they, or others, have gained information. They are able to reflect back on the perceptual access that afforded them, or others, knowledge. Children of this age are able to understand whether knowledge has been gained. However, they cannot consistently say how knowledge has been gained until they reach around 4 years of age. According to Perner (1991) this means that these 4-year-old children are starting to have an understanding of the third and final stage of knowledge: they understand that knowledge must be supported by evidence.

Being able to say how you found something out is not the only way of demonstrating an understanding of sources of knowledge. You also need to understand what source you must use if you want to find out knowledge. For example, you may realise that you know the colour of an item *because you looked* at it, but you also need to understand that if you want to find out the colour then *you need to look* at it. In other words, to comprehend that knowledge must be supported by evidence you must be able to reflect upon how that evidence gave you knowledge, and realise what evidence you need in order to gain knowledge. The following section will discuss how this ability to use sources of knowledge to gain information has been investigated in the existing literature.

5. Active Use of Sources of Knowledge

This review so far has shown that from the age of 3 years, young children are beginning to have the ability to say whether they know something and how they have come to know it. Both abilities require children to reflect upon their knowledge states. As such, the tasks that assess this understanding tend to require children to observe or participate in an activity (e.g., hiding toys in boxes) and then answer questions about the information that has been gained through this action. However, reflection is not the only way to assess knowledge states. Flavell (2000) proposed that a possible difference between children's and adults' understanding of knowledge is that adults have an unprompted awareness of their own and other's mental states and spontaneously use this ability. For example, if an adult wants to find something of a particular colour then she will look: there is no need to consider any other perceptual access. This suggests that assessing young children's active use of sources of knowledge may be more revealing than asking them to reflect on their knowledge. It may be more informative to ask them how they want to find out, than ask them what they know, or how they came to know it.

It seems then, that most sources of knowledge tasks assess children's ability to reflect on how they know something rather than their understanding of how to gain knowledge (Robinson, Haigh, & Pendle, 2008). This limitation does not only restrict what we know about children's active use of sources of knowledge. It is also possible that such reflective procedures do not accurately assess children's understanding of knowledge states. As mentioned previously, children could succeed at tasks that ask them how knowledge has been acquired by repeating the action that has just taken place, rather than really understanding the importance of specific perceptual access as evidence for knowledge states (O'Neill & Gopnik, 1991).

Young children's "working understanding" of sources of knowledge has therefore been investigated (Robinson, Haigh, & Pendle, 2008). In a tunnel they hid one of a pair of toys that were distinguishable only by feeling, seeing part, or seeing the entire toy. Three to 5-year-olds were asked to find out which toy was hidden. They were allowed to look at or feel the toy when it was hidden but the identity of the toy was not always apparent from their mode of perceptual access. However, the children were allowed to carry out additional perceptual access if they wanted to. For example, if they felt the toy in the tunnel and realised that this mode of access did not allow them to identify it, they could choose to look at it. Robinson, Haigh, and Pendle (2008) found that 3 to 4-year-old children were good at knowing when they needed additional perceptual access, but could not always predict what type of perceptual access was necessary. In other words, they realised when they did not know enough, but did not necessarily understand how to gain that extra knowledge.

Other researchers have investigated young children's ability to say what perceptual access they would need to take to find out particular information. Perner (1991) called these “aspectuality tests” as children were required to determine what action to take to find out a specific aspect of a hidden item. For example, O’Neill et al. (1992) asked 3 to 5-year-old children whether they or a puppet would need to feel or see a hidden item to find out, for example, its colour. Their results suggest that 3 and 4-year-olds have difficulty in understanding which perceptual access will lead to which form of perceptual knowledge. While other studies assessing young children’s understanding of aspectuality have taken slightly different formats, they have shown the same results. For example, Pillow (1993) ran experiments where an item was hidden in one of three containers and children had to choose the correct perceptual access to find out where it was hidden (e.g., they had to decide whether to look or feel). He also found that 3 and 4-year-olds did not seem to understand the modality specific aspects of knowledge. They did not know how to find the hidden item.

In summary, young children understand whether they know something and how they have found out that knowledge, before they have the understanding of how to gain knowledge. While both rely on understanding the importance of evidence, there is a distinction between reflection on knowledge (knowing how you know something) and prediction of knowledge (knowing how to find out something). Children aged around 3 years of age are able to correctly reflect on the source of their knowledge, but children under 5 years of age cannot understand which perceptual access will allow them to gain knowledge (e.g., O’Neill et al., 1992; Pillow, 1993). The next section will focus on the development of this latter ability: young children’s understanding of aspectuality.

6. The Development of Aspectuality Understanding

Understanding which perceptual action will lead to a specific kind of knowledge is known as aspectuality (Perner, 1991). Knowing what action you need to take to find something out is a useful ability which can affect later behaviour. For example, as adults we know that picking up a suitcase will inform us about its weight and this knowledge will determine whether we walk to the train station or get a taxi. Looking at the suitcase may inform us about its size, but will not tell us whether it is heavy or light. In this situation, looking would not be useful but feeling would give us the information we need.

For young children to comprehend aspectuality they must understand that a particular form of perceptual access will only lead to certain types of knowledge. For example, that looking will lead to knowledge of colour but not of weight. As such, it is the realisation of the limitations of perceptual actions that signify an understanding of aspectuality. There are two main theories concerning the development of aspectuality understanding in young children and both involve progression through stages of realisation of the importance of sources of knowledge. These theories will now be described in turn.

First, Perner (1991) suggested that young children progress through various stages of understanding the concept of knowledge before they can comprehend aspectuality. Children initially have a behavioural theory of knowledge at around 4 years of age, where knowing is governed by success (as described earlier). They then move on to a representational theory of knowledge after 4 or 5 years of age. This representational theory means that children can think about how they have gained knowledge because they can represent the acquisitions. Once children can represent how knowledge *was* gained, they can then use the representations to understand how knowledge *can be* gained. The representations of knowledge are acquired, interpreted, and then actively used. In other words, possessing a representational theory of knowledge allows children to consider how knowledge is formed; they understand the importance of evidence in justifying knowledge and governing behaviour. Once they understand how knowledge is formed, young children can re-experience events and use that experience to influence their future actions. They then have an understanding of aspectuality (Perner, 1991).

In the second theory, O'Neill et al. (1992) also suggest that children progress through stages of understanding sources of knowledge. These stages culminate in a mature comprehension of aspectuality. During the first of these stages, at around 3 years of age, children understand something about knowledge. As previously stated, they are generally able to understand the difference between knowing and guessing and therefore show some understanding of what it means to be in possession of knowledge. They also understand that perceptual access to a hidden item will lead to knowledge about that item and that a lack of perceptual access will not lead to knowledge. For example, that a person looking at a toy inside a tunnel will be able to identify it, but a person resting his hand on the outside of the tunnel, will not (e.g., Pratt & Bryant, 1990).

During the second stage of understanding the link between perception and knowledge, 4 to 5-year-old children start to recognise the causal relationship between perceptual action and consequent knowledge (O'Neill et al., 1992). As discussed earlier, these children are able to say how they, or others, found out a piece of information: they are able to monitor the source of their knowledge. In other words, they are able to reflect on and state, what specific perceptual action, carried out in the past, led to the acquisition of a piece of knowledge (e.g., Gopnik & Graf, 1988; O'Neill & Gopnik, 1991).

The statements and reasons that children give, when reflecting on the sources of their knowledge, reveal that they understand the causal link between perception and knowledge (e.g., Wimmer, Hogrefe, & Perner, 1988; Wimmer, Hogrefe, & Sodian, 1988). For example, a 3-year-old child asked to justify a puppet's lack of visual knowledge pointed out that the removal of a blindfold would have let "him" know the items colour (O'Neill et al., 1992). However, while 4 to 5-year-olds might be able say how they had found something out, O'Neill et al. (1992) argue that they cannot yet correctly choose what perceptual action is necessary in order for them to gain specific knowledge. That is, 4 and 5-year-olds show retrospective comprehension in that they can remember and explain what previous action led to knowledge (e.g., understanding that you know the colour *because you looked*), but they cannot yet choose what future action is needed to gain knowledge (e.g., understanding that *you have to look* if you want to find out the colour).

Only at the third and final stage of understanding, at around 5 to 6 years of age, do children develop the ability to choose correctly which perceptual action is necessary to obtain knowledge (O'Neill et al., 1992). This third stage of understanding is based on the realisation that knowledge must be supported by evidence and, more specifically, that different evidence supports different types of knowledge (O'Neill et al., 1992). For example, realising that if you want to know an item's colour it is necessary to gain specific evidence from visual access and that other forms of perceptual access will not give you the information you need.

To summarise, Perner's (1991) theory suggests that at around 3 years of age, young children posses a behavioural theory of knowledge and do not understand aspectuality; they base the acquisition of knowledge on successful outcomes. Once young children possess a representational theory of knowledge (at around 4 years of age) they begin to understand that evidence is necessary for knowledge acquisition. They then realise the modality specific aspects of knowledge and start to understand aspectuality (at around 4 or 5 years of age). O'Neill et al.'s (1992) theory suggests that at around 3 years of age young children understand only that perceptual acts lead to knowledge. At around 4 to 5 years of age they are able to reflect on how knowledge has been gained and understand the perceptual evidence behind such information. Finally, at 5 or 6 years of age, young children understand how to use particular perceptual access to gain specific aspects of knowledge; they have a mature understanding of aspectuality (at least as far as looking and feeling are concerned).

The two theories covered here propose that young children develop an understanding of aspectuality somewhere between the ages of 4 to 6 years. However, they do not enlighten us about how robust young children's understanding is, once it has developed. They do not suggest how young children's understanding of aspectuality might have limitations. This is the focus of the current research.

7. The Current Research

Most of the existing aspectuality literature has centred on the development of young children's understanding. Researchers have suggested the ages at which young children can succeed at these tasks (e.g., O'Neill et al., 1992; Perner, 1991). They have also proposed how the development of this understanding might relate to other metacognitive abilities (e.g., Naito, 2003; Perner & Ruffman, 1995). On occasion, research has demonstrated that children are vulnerable to procedural changes, and shown that younger children than expected can perform well at the tasks (e.g., Pratt & Bryant, 1990). Also, researchers have noted that sometimes children seemed to have difficulty with particular instructions during the tasks (e.g., O'Neill et al., 1992). These factors have never been fully explained and suggest that while children might be able to succeed at these tasks their understanding may be less than robust. However, the robustness of young children's understanding of aspectuality has never been investigated. We do not know whether, when young children can succeed at aspectuality tasks, they really understand the modality specific aspects of knowledge; whether their understanding is robust enough to withstand variations and irrelevances; or if we can genuinely say that they understand aspectuality. The current research sought to correct this.

In the seven experiments of this thesis, the robustness of young children's understanding of aspectuality was investigated. Children within the age range of 4 to 7 years were tested. They were given tasks including experimental manipulations that someone with a robust understanding would have had no difficulty with. In the present research, "robust" refers to an understanding that is able to function, without any problems, under a broad range of conditions. Manipulations were created that would test the robustness of children's understanding through a variety of conditions; in the context of presentation; the question phrasing; the item description and the pre-trial experience.

The aim of Experiment 1 was to discover whether children could use their understanding of aspectuality in different situational contexts; by identifying a single hidden item and by locating a hidden item among many. Experiments 2, 3, and 4 investigated children's ability to recognise and ignore irrelevant information that was included in the task. Experiments 5 and 6 sought clarity concerning the influence of pre-trial experience of the items on children's performance in aspectuality tasks. Finally, Experiment 7 explored how different ways of referring to test items might affect children's understanding.

CHAPTER 2 – THE EFFECT OF SITUATIONAL CONTEXT ON YOUNG CHILDREN'S UNDERSTANDING OF ASPECTUALITY: DISCOVERY VERSUS LOCATION

If you want to find something of a particular colour the best action to take is to look. This is true across various situational contexts. For example, if you wanted to locate a blue shirt that you own, then it would make sense to look through the clothes hanging in your wardrobe until you found it. You would realise that using another form of perceptual access, such as feeling, would not be the best way to find this item. It is best to look if you want to *find* something that is blue. Equally, if you wanted to check what colour shirt you had packed in your overnight suitcase, you would realise that the best action to take would be to have a look. It is best to look if you want to discover *whether or not* something is blue.

These examples demonstrate that, as adults, we understand that we need to use particular types of perceptual access to find out specific perceptual information. They also show that we can use this knowledge in different contextual situations: *to find one item among many* (one blue shirt in a wardrobe containing several shirts of different colours) and *to discover a feature of an individual item* (the colour of a shirt in a suitcase). This ability allows us to function effectively in the world, proficiently using our understanding of aspectuality: the link between perceptual access and the subsequent knowledge that can be gained (Perner, 1991). However, it is possible that young children might find it harder to locate an item than to discover information about one, or vice versa, although these tasks have never been directly compared. It is possible that the two tasks require different cognitive abilities: finding out *what* something is and finding out *where* something is. The current research aimed to clarify whether young children could use their understanding of aspectuality to gain information in two such distinct contextual situations.

An understanding of aspectuality requires the ability to predict the correct perceptual access necessary to determine a specific perceptual property (O'Neill et al., 1992). For example, the ability to know that you will need to look if you want to find out the colour of something and the ability to recognise that other perceptual actions will not give you the information that you need. When young children's understanding of aspectuality is investigated, a particular experimental procedure tends to be followed. For example, children are given two items that are the same in one modality (e.g., colour) and different in another (e.g., tactile quality) (see for example, Perner & Ruffman, 1995; Robinson et al., 1997). Children are encouraged to look at and feel these items and they also have these similarities and differences pointed out to them by the experimenter. One of these items is then hidden in a container or tunnel that allows separate visual and tactile access. Finally, the children have to decide whether they (or others) would need to look or feel in order to discover which item has been hidden.

It is not clear whether this task is really assessing a *robust* understanding of aspectuality. As suggested above, a robust understanding would require the ability to cope with variation. Therefore, it would require not only an ability to determine what perceptual action is necessary to find out the perceptual qualities of a single hidden item (what will be referred to as a discovery task). It would also require the ability to determine what perceptual action is necessary to find a single hidden item amongst many (what will be referred to as a location task). For example, someone with a robust understanding would be able to discover the colour of a single pencil in a pencil case, as well as locate a particular coloured pencil in a case full of different coloured pencils. Someone with a robust understanding of aspectuality would have little difficulty with either task: regardless of whether they needed to discover information about the item or locate the item, they would realise that colour is determined by looking. They would understand that other perceptual actions would not be of any help.

In Pillow's (1993) first experiment children also had to discover information about a single hidden item. However, in his following three experiments more than one item was hidden and children had to locate the target rather than discover something about it. In these location studies children were given three items that shared a similar aspect but differed in another (e.g., they felt the same but were all different colours). They also received descriptions of the items by the experimenter. All three items were then hidden: one in each of three containers, all allowing separate perceptual access (e.g., the opportunity to put a hand in and feel the contents without seeing the contents and vice versa). Children were asked to find out which of the three containers was hiding a specific item and had to decide the correct action for themselves or puppets to take (e.g., looking or feeling). In other words, they were asked to choose the correct perceptual action to locate a particular item.

The aim of Pillow's (1993) location studies, however, was not to find out if children found this task more difficult than a standard discovery version of the aspectuality task. Rather, the aim was to compare children's ability to predict the correct perceptual access for themselves to take, with their ability to predict the correct access for a puppet to take.

Consequently, little research has been carried out to investigate young children's ability to choose the correct perceptual access to locate a specific item and none has compared children's performance between location and discovery tasks.

1. Experiment 1 – A comparison of young children's performance on discovery and location versions of aspectuality tasks

The aim of Experiment 1 was to compare these two different types of aspectuality procedures (discovery and location) and establish whether young children find the tasks of differing difficulty. This would then add to the existing literature on the development of their understanding of aspectuality. Three possible outcomes were predicted. First, children could find it easier to locate an item among many (location task) than discover information about a single hidden item (discovery task). This suggestion is based on the experience that children have of the items before they are hidden and while they are hidden. To elaborate, Perner and Ruffman (1995) proposed that the amount of links the child has to make between their initial experience of the items in an aspectuality task and their final experience of those items, may affect their performance in the task. They suggest that the fewer links a child has to make between the items and the necessary differentiating perceptual action, the better their performance. This can be interpreted to suggest that if children have to re-evaluate their initial experience of the items, they have to think about them in a different way. If they have to expend extra cognitive effort considering these items this could have a detrimental effect on their final decision making ability.

The discovery and location tasks in the current experiment vary in the amount of links that need to be made between the initial experience and the final experience. In the location task the number of items that children initially experience and the number that they finally experience do not alter. Children initially experience two items and then still have to consider those two items when asked to locate one of them. No additional links need to be made. Therefore, no additional cognitive effort is required. In the discovery version of the task, however, the children initially experience two items, but then have to consider which one has been hidden. The number of items being considered alters and an extra link is needed. Children first consider two items, and then have to re-evaluate that initial experience when one item is removed. An additional link is made and additional cognitive effort is required. Therefore, Perner and Ruffman's (1995) hypothesis could suggest that children would perform worse on the discovery task, as the extra cognitive effort required to form this additional link would affect their performance.

The second possible outcome is that children may find the location task harder than the discovery task. They may find it more difficult to compare two hidden items in the location version of the task, than deal with a single hidden item in the discovery version of the task. Evidence from the sources of knowledge literature suggests that young children might have difficulty carrying out comparisons. For example, O'Neill et al., (1992) showed that 3 to 5-years-olds found it harder to compare two puppets' knowledge states than consider each one separately. Pillow's (1993) results also offer some support for this hypothesis. For example, in his first study 4-year-olds performed significantly better than would be expected by chance at choosing what action a puppet should take to discover information about a single hidden item. Nevertheless, in his second study 4-year-olds were no better than chance at choosing the action themselves or a puppet should take to locate one item among three that were hidden. However, the comparison between these two task types was not direct and the designs of the studies varied in other ways, so it is unclear whether children found one task harder than the other.

Research from the visual perception literature also suggests that the location task would be harder. This is because in visual perception tasks location has priority over discovery of identity (e.g., Sagi & Julesz, 1985). For example, participants were quicker at identifying a target when they knew its location among four items presented on a screen, than locating a target among the four items when they knew which one they were looking for (Logan, 1975). In other words, if you know where something is, you do not have to spend time thinking about its location and you just have to say which one it is as soon as that information becomes apparent. In contrast, it is more effortful to think about where a target might be, even when you know what you are looking for. When applied to the current research, this argument suggests that children would be more successful at the discovery task. They would know the item's location (it would be the one that was hidden) and would just have to discover which one it was (e.g., the red one or the blue one). However, in the location task children would know which item had been hidden (e.g., the red one) but they would not know its location.

The third possible outcome is that children perform just as well on the discovery task as the location task. This would suggest that their understanding of aspectuality is robust, at least in the context of choosing the correct perceptual action to discover or locate a hidden item. It would demonstrate that their understanding of aspectuality is strong enough to withstand variation in the method of presentation. It would suggest that young children do not expend more cognitive effort forming extra links between their initial and final experiences of the items, as implied by Perner and Ruffman (1995). It would suggest that they do not find it harder to compare two items than consider one, as implied by O'Neill et al. (1992) and Pillow (1993).

Previous experiments carried out by O'Neill et al. (1992) and Perner and Ruffman (1995) suggest that children cannot succeed at aspectuality tasks until they are at least 5 years of age. Therefore, Experiment 1 assessed the performance of 5 and 6-year-olds on both the discovery and location versions of an aspectuality task.

1.1 *Method*

Participants

Seventy-two children participated from a school serving a predominately working class population in Leeds, U.K. Thirty-six 5-year-olds (24 girls) participated. Their ages ranged from 5 years and 2 months (5;2) to 6 years and 1 month (6;1) with a mean age of 5 years and 7 months. Thirty-six 6-year-olds (range 6;2 to 7;1, mean 6 years and 7 months; 19 girls) also participated. They were all reported by their teachers as possessing a good understanding of English. Ethnicity was distributed as follows: White (45), Asian (12), Black (5) and other (10).

Materials

The materials consisted of five balls, two tunnels, an opaque bag and an opaque cloth. The balls were approximately 7 cm in diameter and were used as the test items. One ball was green, two balls were red, and two were blue. The green ball was filled with polystyrene beads and felt like a bean bag. One of each of the red and blue balls were filled with cotton wool and felt soft. The other red and blue balls were filled with solid plaster and felt hard. The fillings fitted inside thin foam layers within outer fabric covers, so that balls that were the same colour and had different fillings were indistinguishable by sight. The balls were kept in the bag when not in use.

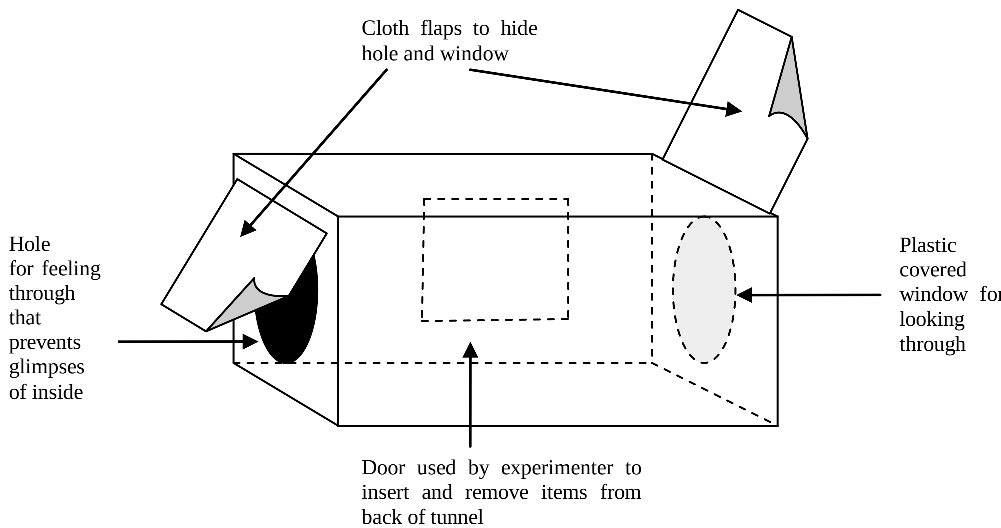

Figure 1

Example of a tunnel used to hide the balls.

Two identical grey tunnels measuring approximately 30 cm x 10 cm x 10 cm were used to hide the balls (see Figure 1). The tunnels were identical, with 5 cm diameter holes cut in their 10 cm x 10 cm ends and “hook and loop” patches that allowed the tunnels to be securely stacked on top of each other. On one end of each tunnel the holes were covered with clear plastic, forming windows that could be looked through to see inside. On the other end of each tunnel the holes were covered by pieces of black felt with two diagonal slits cut into them, so that a child's hand could pass through. Black felt squares were attached at the top of the outside of the ends of the tunnels, so that the windows and feeling-holes were covered with flaps of felt that had to be lifted up in order to look in or put a hand in. Each tunnel also had a door on the back panel that could be opened by the experimenter, through which the balls were inserted and removed. The cloth was used to hide the movements of the balls, both their positioning in the tunnels and their transfer from the bag.

Design

Every child was familiarised with the equipment and then received eight experimental trials: four location trials and four discovery trials. The order of trials was counterbalanced, but to help keep the task simple for children and to allow checks for order effects, half the children were given their location trials before their discovery trials and the other half received their discovery trials first. Two of each of the discovery and location trials required looking to succeed and two of each required feeling to succeed. Children were assigned in turn to one of two orders of trial presentations based on their teacher's class list. The trial orders were as follows: (i) Look, Feel, Feel, Look, Feel, Look, Look, Feel (LFFLFLLF), (ii) FLLFLFFL. The colour or feel of the target item and its position in the tunnels in the location trials (top or bottom tunnel) was counterbalanced. The question order was alternated between children so that half were asked if they wanted to "look or feel" to discover or locate the target in each of their trials and the remainder if they wanted to "feel or look".[1]

Procedure

Familiarisation. Children were tested individually in a quiet room while sat at a table opposite the experimenter.[2] Children were shown the bag, and then were told that it contained some balls and that they were going to play a game with them. A tunnel was placed on the table and the children were informed that a ball would be put inside. The experimenter took the green ball from the bag and placed it inside the tunnel through the back door (under the cloth so that the children could not see). The experimenter then pointed to the appropriate end of the tunnel and explained that on one end of the tunnel, under the flap, there was a window that would let them see which ball was inside. To check that they understood how to carry out the correct procedure, the children were asked to lift the flap, look inside, and say the colour of the ball. They were then informed that the ball was being removed from the tunnel and another one inserted (to convey that no ball was left in the tunnel between trials) although under the cloth the same ball was actually reinserted. The experimenter then pointed to the other end of the tunnel and repeated the procedure with the tactile access point: Children were asked to lift the flap, put their hand inside the tunnel and say what the ball felt like.

The experimenter explained that for every go of the game they would have to decide whether they wanted to look or feel to find something out about a ball that was hidden in a tunnel. It was emphasised that they would only be allowed to carry out one of the actions.

---

[1] Counterbalancing of question order, modality of target, and location of target was the same for all subsequent experiments.

[2] This was the same for all subsequent experiments.

As a check of their understanding of the difference between the two modes of access, the children were then asked which side of the tunnel they would use if they wanted to look inside and which side they would use if they wanted to feel inside.

Main trials. The two tasks were designed to be as similar as possible apart from the necessary differences regarding the number of items that were hidden. For the discovery trials an aspectuality task used by O'Neill et al. (1992) was adapted. Children were initially presented with two items that both looked the same and felt different, or vice versa. One of the items was then hidden in a tunnel while the other was removed. For the discovery trial test question children were asked whether they needed to look or feel to find out about the hidden item (e.g., to find out if *it was the blue one*).

For the location task an aspectuality task used by Pillow (1993) was adapted. In his task children were presented with three items that shared one perceptual property but differed in another. In Pillow's study all of the items were then hidden, one in each of three containers. In the current experiment's location task two items were hidden in two tunnels. For the location trial test question children were asked what perceptual access was needed to locate one of the items (e.g., find *the blue one*).

At the beginning of each trial the children were handed the two balls that were going to be used in that trial and asked to, "look at them properly and feel them properly". This was done while the experimenter pointed out the perceptual attributes of each ball in turn, for example, "this one is red and soft". The experimenter then retrieved the balls. The movements of the balls into the tunnel(s) and bag took place underneath the cloth so that the children could not see which ball was placed where. Once the balls were in place the test question was asked.

In the discovery trials the children were told that one of the balls would be hidden in a tunnel and the other one would be put back in the bag. For two of the discovery trials the test question matched the ball that was hidden, for the other two trials it did not. For example, if the red ball was hidden the matching question was, “find out if it’s the red one”, whereas the non-matching question was, “find out if it’s the blue one”. This was so that children did not always have to confirm that it was the target ball that had been hidden. Children were asked if they wanted to look or feel (using their allocated question order). In the location trials the children were told that both of the balls would be hidden, one in each of two tunnels. In the location trials the children were asked to find out which tunnel contained, for example, “the red one” by choosing to look or feel (using their allocated question order).

The children’s responses were noted and they carried out their chosen action. They were then asked to indicate to the experimenter which tunnel they thought contained the target item (location) or whether it was the target item (discovery). They were not permitted to carry out the alternative action. The children were then given the ball that had been hidden in the discover trials and the ball that they had chosen in the location trials. However, the experimenter offered no correction or feedback. After the ball was retrieved from the child the next trial was started. When children changed over from one trial type to another, they were told that the next game would be slightly different and that either an extra tunnel would be needed or that just one tunnel would be needed. Children were rewarded at the end of their trials with a sticker.

1.2 *Results*

Scoring

All children named the colour and feel of the ball hidden in the familiarisation procedure and passed the familiarisation check (which side of the tunnel allowed looking and which side allowed feeling). Therefore, all 72 children took part in the main experiment. For the main trials children were given a score of 1 for each correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 1).

Analysis

The presentation orders in Experiment 1 had been counterbalanced but analysis was also carried out to ensure that no order effects had influenced children's performance. Independent sample *t* tests showed that children who had received the "look or feel" question order (M = 5.73, SD = 2.09) performed no differently to those who had received the "feel or look" question order (M = 6.41, SD = 1.13), $t(70) = -1.66$, $p = .101$, $r = .19$. Children's performance was not affected by either of the two trial orders (lowest p = .28).[3] Children who had received the discovery trials before the location trials (M = 5.75, SD = 1.99) performed no differently to those who had received them in the reverse order (M = 6.31, SD = 1.45), $t(70) = -1.35$, $p = .18$, $r = .16$.

---

[3] The statistical analysis of trial orders is not reported in the remainder of this thesis.

Table 1

Number of trials answered correctly in Experiment 1

Age	Task Type	Number of trials correct 0	1	2	3	4	Mean (Standard Deviation)
5-year-olds	Discovery (*n*=36)	1	4	7	12	12	2.83 (1.11)***
	Location (*n*=36)	1	4	11	11	9	2.64 (1.07)***
6-year-olds	Discovery (*n*=36)	0	2	2	10	22	3.44 (.84)***
	Location (*n*=36)	1	2	6	8	18	3.14 (1.07)***
Expected frequencies if performance were at chance		*2.25*	*9*	*13.5*	*9*	*2.25*	*2*

N.B. Performance significantly different than would be expected by chance is indicated throughout this thesis by * ($p < .05$), ** ($p < .01$), *** ($p < .001$) and *ns* = not significant. Frequencies for looking and feeling trials for all experiments are displayed in cross tabulation format in the appendix of this thesis.

A repeated-measures analysis of variance (ANOVA) was carried out with age (5-year-olds and 6-year-olds) as a between-subject factor and task type (discovery and location) and modality (looking trials and feeling trials) as within-subject factors. A main effect of age was found, $F(1, 70) = 7.95$, $p = .006$, $\eta^2_p = .10$, where 6-year-olds ($M = 6.58$, $SD = 1.65$) performed better than 5-year-olds ($M = 5.47$, $SD = 1.70$). There was no effect for task type or modality, nor were there any interactions (highest $F = 3.17$, lowest $p = .08$, indicating that modality was approaching significance as performance on feeling trials was slightly better than performance on looking trials).

While there was no difference in children's performance on the discovery and location tasks, a Pearson's correlation was conducted to find out if there was a linear relationship between the two tasks. The correlation on the discovery and location tasks was significant for 6-year-olds, $r = .47$, $p = .004$, but not for 5-year-olds, $r = .21$, $p = .21$. These results suggest a tendency for younger children to succeed at the discovery task before the location task.

Analysis was also carried out to see if children's performance improved over time. If their performance was better on the later trials than on the earlier trials children may have been learning from their mistakes. No difference between the two times would show that children who initially choose the wrong mode of access did not realise their error and later correct it. Paired-sample *t* tests showed that in the discovery task children performed no differently in their first two trials ($M = 1.64$, $SD = .61$) to their last two trials ($M = 1.50$, $SD = .71$), $t(71) = 1.40$, $p = .17$, $r = .16$. Also in the location task children performed no differently in their first two trials ($M = 1.40$, $SD = .73$) to their last two trials ($M = 1.47$, $SD = .67$), $t(71) = -.71$, $p = .48$, $r = .08$.

Finally, analysis was carried out to discover whether children were guessing, or whether some of them were performing well and some were performing poorly. Pearson's

Chi-square tests allowed comparisons of the goodness of fit between individual children's performance and the values expected if they were performing at chance. The interest here (and in the other experiments in this thesis) was whether individual children were getting more trials correct than would be expected by chance. The analysis of the Chi-square tests showed that 5-year-olds performed better than would be expected by chance in the discovery task, χ^2 (4, N = 36) = 49.85, $p < .001$ and in the location task, χ^2 (4, N = 36) = 24.63, $p < .001$. Six-year-olds also performed better than would be expected by chance in the discovery task, χ^2 (4, N = 36) = 190.96, $p < .001$ and in the location task, χ^2 (4, N = 36) = 120.56, $p < .001$.

1.3 *Discussion*

Experiment 1 assessed whether young children's understanding of aspectuality was robust enough to deal with choosing whether to look or feel to gain perceptual information in different contexts. This was done by comparing their ability to choose the correct perceptual action to discover information about and locate hidden items. Five and 6-year-olds performed well at both tasks, although 6-year-olds were overall more successful than 5-year-olds. These findings will now be discussed in more detail, specifically how they relate to the existing aspectuality literature and the three possible outcomes considered in the introduction to this experiment.

The results of Experiment 1 showed that children performed no different on the location task to the discovery task. They also performed well above chance levels, although they were not correct on all their trials. This supports O'Neill et al.'s (1992) suggestion that by the ages of 5 or 6 years, children show an understanding of aspectuality. The current findings also demonstrate that children of this age have a robust enough understanding of aspectuality to be able to deal with these two different situational contexts. They realised that it did not matter whether they had to discover information about a hidden item or locate a hidden item, if they wanted to find out colour they chose to look, and if they wanted to find out tactile information they chose to feel.

Perner and Ruffman (1995) proposed that children's performance on aspectuality tasks was dependent on the number of links that children have to make from their initial contact with the items to their final consideration of the items. This was interpreted to suggest that based on the cognitive effort required, children would find the location task easier. This was because children would have to consider two items in the familiarisation procedure before the task and two items in the task itself. Therefore, they would not have to think about the items in any different way when they were asked the test question. In the discovery task, however, children would consider the two items in the familiarisation procedure and then one item in the task itself. In this case they would have to consider that one of the items was hidden, thus adding an extra step in their reasoning processes before they answered the test question. However, the results of Experiment 1 showed that children did not find the discovery task any harder than the location task. This suggests that in the final stage of the aspectuality task children do not find it any more effortful to consider two items than to consider one item.

In contrast, research carried out by O'Neill et al. (1992) and Pillow (1993) suggested that young children might have more difficulty with a location version of the aspectuality task. O'Neill et al. (1992) implied that it may be more difficult for children to compare two things than consider them in turn and Pillow's (1993) data suggested that young children might find an aspectuality task easier if they have to consider only one hidden item. Also, the visual search literature (e.g., Logan, 1975) implied that identification is less effortful than location, and this was interpreted to suggest that children might find the location task more difficult. However, the results of Experiment 1 showed that neither 5 nor 6-year-olds found the location task any harder than the discovery task. In fact, 6-year-old's performance on the two tasks was highly correlated suggesting that a strong dependence exists between them.

What must be considered is that Pillow's (1993) location tasks were carried out with children no older than 4 years of age. In the current experiment 5-year-olds were tested and performed above chance levels, but the findings showed a slight decrease in their performance on the location task. Their performance on the two task types did not correlate and suggested that they had a tendency to be able to succeed at the discovery task before they could succeed at the location task. It is possible that the younger the child is, the harder they will find the location task. However, Pillow's (1993) 4-year-old's performance was no better than would be expected by chance and, as stated previously, the discovery and location tasks were not directly studied or compared. If future research compared 4-year-old's performance on these two tasks it may reveal whether young children can succeed on the discovery task before the location task.

In summary, Experiment 1 aimed to find out whether young children had the ability to understand what perceptual access they needed to find out particular perceptual information. More specifically the intention was to discover whether children were able to understand aspectuality regardless of whether they had to discover information about a hidden item or locate a hidden item. This was based on the assumption that someone with a robust understanding of aspectuality would have no difficulty with either task. The suggestion was that if young children performed well at both of these tasks, then their comprehension of aspectuality could be described as robust and that this would support some of the extant literature (e.g., O'Neill et al., 1992). The findings from Experiment 1 showed that 5 and 6-year-olds performed equally well on both tasks. Young children did not have any difficulty dealing with different contextual presentations of aspectuality tasks. This provides a valuable addition to the field of study, increasing the possibilities for manipulation of method and design in experiments assessing young children's understanding of aspectuality. The following experiments have made use of these findings by using either discovery or location tasks according to experimental design requirements.

CHAPTER 3 – THE ROBUSTNESS OF YOUNG CHILDREN'S UNDERSTANDING OF ASPECTUALITY: IGNORING IRRELEVANT INFORMATION

The study referred to here as Experiment 4 has been published as: Waters, G. M., & Beck, S. R. (2009). The development and robustness of young children's understanding of aspectuality. *Journal of Experimental Child Psychology*, *103*, 108-114.

The previous experiment showed that young children were able to choose correctly whether to look or feel to either discover information about a hidden item or locate a hidden item. The conclusion was that in this area, at least, 5 and 6-year-old children seemed to have robust understanding of aspectuality. They understood which perceptual access would lead to a specific piece of knowledge, regardless of the situational context. However, possessing a robust understanding of aspectuality means more than just knowing how to locate or discover information about a hidden item. The aim in the following three experiments was to establish further the robustness of young children's understanding of aspectuality. This was done by assessing their ability to recognise that irrelevant information included in the task would not be useful to them.

An understanding of aspectuality, as defined by O'Neill et al. (1992) requires comprehension of how an item is made up of many separate factors, each of which can be identified by different perceptual actions. When it is clear what type of perceptual access will lead to specific perceptual information, no difficulty should be experienced. For example, someone with a robust understanding of aspectuality will always comprehend that looking is the best way to find out the colour of something. Evidence suggests that when someone is skilled in a task, the presence of irrelevant information offers no distraction (e.g., Haider & Frensch, 1999). So, one would expect that someone with a robust understanding of aspectuality would be able to ignore irrelevant information regarding other perceptual qualities.

For example, imagine several cans of soda on a table. If told to find out which one was half-full, an adult (with a robust understanding of aspectuality) would pick up each in turn rather than examine the different labels on the cans. How the cans looked would be irrelevant. Looking would not give the information required. Similarly, if told to identify a can of a particular brand of soda, a robust thinker about aspectuality would visually examine each can rather than base her decision on how each can felt. This time how the cans felt would be irrelevant: feeling would not give the information required. One way to examine the robustness of young children's understanding of aspectuality is to include irrelevant information in the task and assess their ability to disregard it.

Evidence suggests that young children can show quite advanced understanding of how to deal with irrelevant information. For example, children as young as 3 years of age are able to select information that is relevant and ignore information that is irrelevant in visual search tasks (e.g., Sophian & Wellman, 1980). However, young children's understanding of aspectuality has never been tested in terms of whether they can differentiate relevant and irrelevant information. If they possess a robust understanding of aspectuality, then they should be able to deal with situations where an aspectuality task contains additional, but irrelevant information. They should realise that the irrelevant information can be disregarded. However, a more fledgling understanding may be upset by the introduction of irrelevant information.

The following three experiments used an adapted version of a location aspectuality task used by Pillow (1993). In his task, children had to choose the correct perceptual access needed to locate one of three hidden items. Using multiple items in this way in the current experiment allowed different types of manipulation to take place, with regard to the inclusion of irrelevant information. A version of the task as used by O'Neill et al. (1992), where one item was hidden and information about it had to be discovered, would not have allowed such manipulations to take place.

The first experiment of this chapter (Experiment 2) aimed to clarify whether 4 to 5-year-olds could pass an aspectuality task. Although many researchers (e.g., O'Neill et al., 1992; Perner & Ruffman, 1995) had suggested that children of this age might have difficulty with this task, the findings from Experiment 1 suggested otherwise. The 5 and 6-year-olds tested in Experiment 1 performed well above what would be expected by chance so it was possible that 4 to 5-year-olds could be correct on a significant proportion of trials.

Experiment 2 also aimed to assess the robustness of children's understanding of aspectuality by introducing an irrelevant piece of information to the test question. In the aspectuality literature the test question usually referred to either the identity of the object (e.g., "which one is it"), or just referred to the differentiating modality (e.g., "is it the *red* one") (but see Experiment 7 for further investigations concerning the phrasing of the test question). In Experiment 2 the manipulation that was introduced meant that *both* the perceptual modalities of the target were stated in the test question, including the modality that offered no differentiation of the target from the other items. For example, children were asked to find ‘the *red heavy* one’ when both items were heavy and differed only in colour. In this case mentioning the tactile quality of the target was irrelevant.

Children should ignore the irrelevant information in the test question. They should realise that it was unhelpful. They should realise that it would not help them decide whether they needed to look or feel to find the target. As such the irrelevant information should be ignored by those with a robust understanding of aspectuality. If children who heard both features of the target mentioned were still able to choose the correct perceptual modality to locate the target, then it could be said that their understanding was robust: they realised which information they could ignore. However, if they were unable to ignore the irrelevant description, then they would have difficulty choosing the correct modality to locate the target.

If an individual’s performance is disrupted by the addition of irrelevant information, then their understanding cannot be robust. It would mean that they could not remember that the items differed by colour or tactile quality. They must depend on the information in the test question to direct them towards the correct perceptual access. For example, if they are asked to find something that is red then they understand that they must look. When this information in the test question includes irrelevant descriptions their understanding is disrupted. What this suggests is that children might be able to succeed at aspectuality tasks just by making an association. In other words, they might associate the quality mentioned (if one is mentioned) in the test question with the relevant perceptual modality, for example, finding the “red” one and “looking”.

In the second study in this chapter (Experiment 3) this manipulation was repeated with 5 and 6-year-old children. An additional piece of irrelevant information was also introduced in the array of items that were used in the task. This additional information in the array of items would also not assist in the decision of whether to look or feel to locate the hidden target and could be ignored by those with a robust understanding of aspectuality. Again, it was proposed that if children were able to ignore this irrelevant information, then this would demonstrate the robustness of their understanding. If, however, they had difficulty dealing with this irrelevant information, then this would suggest that their understanding was fragile and they were vulnerable to variations in the task. Experiment 4 aimed to clarify the influence that this irrelevant information in the array of items had on 6-year-old children's performance.

1. Experiment 2 – Are young children able to ignore irrelevant information included in the test question?

In this experiment the intention was to investigate whether 4 to 5-year-old children were capable of understanding aspectuality by assessing their ability to choose the perceptual access necessary to find a hidden item under different conditions. A location task was used, where two items were hidden and one had to be found. The items shared one perceptual modality (e.g., both were soft) and differed in another (e.g., one was red and one was blue). In one condition (the simple question condition) children were asked to choose whether they wanted to look or feel to find one of the items, for example, one that was red. A second condition assessed whether the children possessed a robust understanding of aspectuality. In this condition (the complex question condition) children also received irrelevant information about the target item that they had to find. For example, children were asked to choose whether they wanted to look or feel to find an item that was red and heavy (when both the items in that trial had felt the same and only differed by colour).

According to the existing literature children of this age would not perform well in either condition. For example, Perner and Ruffman (1995) proposed that only when children reached 6 years of age would they be able to choose the necessary perceptual access to find an aspect of an item. However, the findings from Experiment 1 showed that even 5-year-olds performed well above what would be expected by chance. It was also important to establish whether children younger than the literature suggested could succeed at an aspectuality task. Therefore, as well as assessing their ability to deal with irrelevant information, the intention was to investigate whether or not 4 to 5-year-old children could succeed at choosing the correct mode of perceptual access to find an aspect of a hidden target item.

1.1 *Method*

Participants

Thirty-one children (16 girls) participated from a school serving a predominately working class population in Birmingham, U.K. Their ages ranged from 4;5 to 5;4 (mean 4 years and 10 months) and they were all reported by their class teachers as possessing a good understanding of English. Ethnicity was distributed as follows: Asian (20), White (9) and Black (2). One child did not appear to understand the instructions and was unable to complete the task therefore the final sample consisted of 30 children.

Materials

The materials consisted of the target items (sixteen balls), four bags in which they were to be hidden and an opaque bag and cloth. The balls were similar to those used in

Experiment 1. They were approximately 7cm diameter and covered in a plastic-coated fabric that was red, blue, green or purple. One ball of each colour contained one of the following fillings – soft foam all the way through (known as *soft*), a thin soft foam outer layer with a wooden cotton reel inside (*knobbly*), a thin soft foam outer layer filled with polystyrene beads (*bobbly*), or a thin soft foam outer layer with a solid plaster middle (*heavy*). The fillings were all round and fitted exactly inside the fabric cover so that four balls of the same colour but different 'feels' were indistinguishable by sight.

Four fabric drawstring bags (each approximately 30cm x 20cm) were used to hide the balls during the procedure. The bags replaced the tunnels used in Experiment 1. This was because of several suggestions of biases towards looking or feeling when using the tunnel format (e.g., Robinson et al., 1997). Using the tunnel gave children the opportunity to use their hands to feel inside, and to lift up a curtain to look inside. However, using the bag made it easier for the experimenter to take control of the children's perceptual actions. The experimenter could offer the base of the bag to the children and allow them to feel the ball through the bag, or the experimenter could open the bag towards the children and allow them to see the ball inside the bag. In this way, the children were carrying out only the actions that they chose and not associated secondary actions.

The bags were constructed of thin double layers, with black fabric on the outside, so that the bags were opaque. Pale yellow fabric was used to line the bags so that when looking at a ball in the bottom of the bag, the colour of the ball was easy to see.

Design

Every trial consisted of two balls being hidden, each in a bag. The balls in each trial either looked the same and felt different, or felt the same and looked different. Children had to decide whether to look inside or feel both bags to find out which bag contained the target item. Children were allocated in turn to one of two question type conditions according to their position on the teacher's class list. Those in the simple question condition were asked to find the target ball with only the relevant modality description mentioned (e.g., "find the red one"). Those in the complex question condition were asked to find the target item with both the modality descriptions mentioned (e.g., "find the red heavy one").

Every child had four experimental trials, two that required looking to find the target item and two required feeling. Children were allocated in turn to one of four orders of these trials as follows: (i) Look, Feel, Look, Feel (LFLF), (ii) LLFF, (iii) FFLL, (iv) FLFL.

Procedure

*Familiarisation***.** First, children were familiarised with the materials. They were presented with four balls that felt the same (soft) but were different colours (red, blue, green, and purple). The experimenter described these perceptual qualities while the children were encouraged to look at and feel the balls. The experimenter then placed each ball into a bag and explained that "if we want to know what colour one is in each bag we don't need to take it out and have a look – we can look inside the bag" before demonstrating the action. The children were then asked to look inside each bag and say the colour of the ball within. Second, the children were encouraged to look at and feel four balls that were the same colour (blue) but felt different (soft, knobbly, bobbly and heavy), while receiving verbal descriptions from the experimenter. The experimenter then placed each ball into a bag and explained that "if we want to know what each one feels like in its bag we don't need to take it out and feel it – we can feel it through the bag" before demonstrating the action. The children were then asked to feel each bag and say the "feel" of the ball within.

Practice Trials. As younger children were being tested in this study than in Experiment 1 they were given practice trials. The purpose was to help children understand the task by giving them experience of the procedure and feedback following their performance (see O'Neill et al., 1992). Each child was given a practice trial for looking and feeling. Two balls were used in the looking practice (green soft and blue soft). The child was given the balls, encouraged to look at them and feel them and told that they felt the same but looked different. The child was then asked to put them each in a bag. The experimenter then took the bags from the child and moved the bags around saying "I'm going to jumble the bags up like this", whilst being careful that the bags' final resting place was out of reach of the child. The child was then told, "I want you to find the green one, but you can only do one thing – you can either look in the bags or you can feel the bags. What do you want to do to find the green one?" If the child chose the correct action they were allowed to carry it out and told that they were right. If the child chose the incorrect action they were told, "No, we need to find out what colour it is, so we have to look" and were shown the correct action. A similar procedure was carried out for the feeling practice with two balls that looked the same but felt different. On the practice trials twenty children correctly chose to feel to discover the tactile aspect and thirteen correctly chose to look to discover the visual aspect.

Main Trials. The experimental trials were similar in procedure to the practice trials. Children were shown and told about the balls in each trial and encouraged to look at them and feel them before they put them into bags. Then children were told the target ball they had to find (using the appropriate question type for their condition) and asked whether they wanted to look or feel (or feel or look) to find it. To recap, those children given the simple question were asked to find, for example, “the red one”. Those given the complex question were asked to find, for example, “the red heavy one” (when heavy was irrelevant as both balls in that trial felt that way). The relevant, differentiating modality was always mentioned first.

Once children had been given their appropriate test question their responses were noted and they carried out their chosen action. They were then asked to indicate to the experimenter which bag they thought contained the target item. Unlike the practice trials they were not given any feedback or corrected. Children were only allowed to carry out the access they had chosen for that trial. That is, they were not permitted to carry out the alternative mode of access. Children were handed the item from their chosen bag without any comment from the experimenter. The items were retrieved from the children and the other bag before the next trial began. At the end of their trials every child was rewarded with a sticker.

1.2 *Results*

Coding

Thirty children were able to name the colours and feels of the balls hidden in the familiarisation procedure and so took part in the main experiment. For the main trials children were given a score of 1 for each correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 2).

Analysis

The first analysis was to find out if being corrected by the experimenter during the practice trials affected children’s subsequent performance in the main experimental trials. Therefore, children’s scores on their practice trials were recoded into those who were correct on both their trials (*N* = 12) and those who were incorrect on one or both trials (*N* = 18). An independent samples *t* test was used to compare these groups' performance on the main trials. Children who were right on both their practice trials (*M* = 2.75, *SD* = .97) performed no differently in the main trials to those who did less well in their practice trials (*M* = 2.56, *SD* = 1.10), *t*(28) = -.50, *p* = .62, *r* = .09.

Table 2

Number of trials answered correctly in Experiment 2

Question Type	Number of trials correct					Mean (Standard Deviation)
	0	1	2	3	4	
Simple (*n* = 16)	0	2	7	2	5	2.63 (1.09) **
Complex (*n*= 14)	0	1	7	2	4	2.64 (1.01) **
Expected frequencies if performance were at chance (n=16)	*1*	*4*	*6*	*4*	*1*	*2*

A repeated-measures ANOVA was carried out with question type (simple and complex) as a between subject factor and modality (looking trials and feeling trials) as a within subject factor. The results showed a main effect of modality, $F(1, 28) = 5.47$, $p = .027$, $\eta^2_p = .16$. Children performed better on the feeling trials ($M = 1.54$, $SD = .57$) than on the looking trials ($M = 1.10$, $SD = .85$). There was no effect of question type and no interaction (highest $F = .112$, lowest $p = .741$).

Analysis was then carried out to see if children's performance improved over time. Paired-sample *t* tests showed that children who received the simple question type performed no differently in their first two trials ($M = 1.38$, $SD = .62$) to their last two trials ($M = 1.25$, $SD = .68$), $t(15) = .70$, $p = .50$, $r = .18$. Also, children who received the complex question type performed no differently in their first two trials ($M = 1.36$, $SD = .50$) to their last two trials ($M = 1.29$, $SD = .61$), $t(13) = .56$, $p = .58$, $r = .15$.

Analysis was carried out to assess whether children were guessing, or whether some of them were performing well and some were performing poorly. In both the simple and complex question conditions, there was a peak of children getting half their trials correct. In the complex question group, five of the seven children who were correct on half their trials were biased towards feeling: they achieved a score of two because they asked to feel on all their four trials. The other two children were correct on one looking trial and one feeling trial: they were guessing. In the simple question condition, however, only two of the seven children showed the bias towards feeling. Finally, individuals' observed scores were compared to chance. Children who received the simple question performed better than would be expected by chance, χ^2 (4, N = 16) = 19.17, p = .001, as did those who received the complex question, χ^2 (4, N = 14) = 15.05, p = .005.

1.3 *Discussion*

The results of Experiment 2 showed one main effect: that 4 to 5-year-old children performed better in their feeling trials than in their looking trials. The bias towards feeling was apparent both in the practice trials and the main trials. As mentioned in the literature review, children who show biases towards particular modalities do not have an understanding of the modality specific aspects of knowledge. Nevertheless, the results of the current experiment suggest that more children than would be expected by chance were correct on all of their trials, and therefore did not show biased behaviour. The 4 to 5-year-olds tested in Experiment 2 performed better overall than the existing literature had suggested they would (e.g., Naito, 2003; Perner & Ruffman, 1995).

Despite the bias towards feeling, it is still possible to examine the effect of the question manipulation. The current findings demonstrated that the 4 to 5-year-olds tested understood that they could ignore the irrelevant information in the test question. Children who were given the complex question performed no differently from those given the simple question. Contrary to what was hypothesised, the presence of irrelevant information about the target item in the test question caused children no extra difficulty. Four to 5-year-old's understanding of aspectuality was robust enough to withstand this variation to the test question, challenging the assumptions made by the aspectuality literature (e.g., O'Neill et al., 1992). The current findings support research in other areas of cognitive development which suggests that young children are able to ignore irrelevant information (e.g., Sophian & Wellman, 1980).

Although the children tested in this experiment performed surprisingly well, it is possible that by always describing the relevant modality first in the complex question their decision making was unintentionally influenced. They may have focused on this initial word and disregarded the second modality mentioned. This may have made the complex and simple questions functionally equivalent. Nevertheless, there is no evidence here to suggest that children ignored the second part of the description. However, future research could investigate whether children only ever attend to the first part of a verbal description.

On a similar point, always mentioning the relevant modality first in the complex question may have led to descriptions that were not always what would be expected in English language and this may have drawn children's attention to unusual word arrangements. For example, there is a tendency in English for the *canonical order effect* to occur, where a colour term is used *after* any other description, rather than before (e.g., Martin, 1969; Martin & Molfese, 1972). In Experiment 2, the description used in a looking trial (e.g., "find the red heavy one") would have been more unusual than the description used in a feeling trial (e.g., "find the heavy red one"). If the unusual description had attracted children's attention more, one might have expected performance on these trials to be at ceiling level. However, this was not found. In fact, it may have been that children preferred the more standard description as they showed a bias towards feeling in this study (although there is no evidence from the other experiments in this thesis that such word arrangements were responsible for modality biases).

It is possible that the differentiating modality could have been mentioned second, rather than first. In some contexts, the more specific an adjective is to a noun, the closer it tends to be to it (Belke, 2006). For example, it may be more usual to describe an item as “the big red bus” rather than “the red big bus.” This is because all buses tend to be big, but the colour is more specific; the bus could be any colour. However, evidence also suggests that it is beneficial to hear the distinctive features of a target *before* hearing about features that do not distinguish it from others (e.g., Belke, 2006; Eberhard, Spivey-Knowlton, Sedivy, & Tanenhaus, 1995). It seems that the existing evidence is inconclusive regarding the correct positioning of the relevant descriptive word. Further research is required to determine whether either of these descriptive arrangements would make a difference to young children’s performance in aspectuality tasks.

As another alternative, one modality could always have been mentioned first in the test question, rather than the relevant modality. For example, the colour could always have been stated after the tactile quality to ensure a less unusual conjunction of words. However, this in turn may have influenced children’s preference for a particular perceptual action by drawing their attention to the fact that the colour was always mentioned first. Once again, further research is needed to determine whether this arrangement would have any effect on children’s performance, but there is no conclusive evidence to suggest that the phrasing used in the current research caused any particular difficulty.

In conclusion, 4 to 5-year-olds were able to pass the tactile simple and complex questions in Experiment 2. It appeared that children of this age were not affected by including irrelevant information in the test question. Despite all the possibilities just mentioned, the descriptions used in Experiment 2 did not seem to be considered to be unusual by the children tested. While a bias towards feeling was found, it is more likely that this was influenced by the use of bags to hide the items, rather than how the descriptions of the items were presented. The bags provided a novel action of feeling an item through cloth that the children seemed to prefer. The modality bias prevented a thorough evaluation of the robustness of children's ability to succeed at this task. Another experiment was necessary to investigate more fully the effect of irrelevant information on young children's understanding of aspectuality.

2. Experiment 3 – Young children's ability to ignore irrelevant information in alternative contexts

The 4 to 5-year-olds that were tested in Experiment 2 had not been affected by the irrelevant information in the complex test question in the aspectuality task. However, including irrelevant information in the test question is not the only way of testing robust understanding of aspectuality: a robust understanding should be sturdy enough to be able to withstand different changes and variations. In an aspectuality task there are alternative contexts for including irrelevant information that someone with a robust understanding should have no difficulty dealing with. One alternative involves introducing an irrelevant factor in the array of items that are presented.

According to Piaget (1941), young children can find it difficult to focus on more than one feature of a display: a behaviour known as centration. For example, in the classic conservation task, children observe a number of counters being arranged in a row. When the counters are moved closer together children are asked whether there are now the same number of counters, or fewer, or more. Children who centrate, believe that there are fewer counters even though none have been removed from the display. These children focus on the fact that the arrangement is now smaller, rather than take into account that the number of counters has stayed the same. They focus on the physical size of the display, not the contents. When children are able to decentre, or focus on more than one feature, then they are potentially able to recognise which feature is relevant. In particular, which feature is relevant for the question that they have been asked and which is irrelevant.

An understanding of sources of knowledge also requires the ability to focus on more than one feature of an item and decide which is relevant. This is particularly so when multiple items are presented, for example, in an aspectuality task. In this situation, the items presented would share one perceptual modality and be different in another. Two features of one of these items must, therefore, be recognised; the modality that makes the item the same as the others and the modality that makes the item different to the others. Understanding aspectuality requires the realisation that the way in which the item is different is what determines the way in which that item can be identified, when hidden. The way in which the items are the same is irrelevant.

In Experiment 3, therefore, the robustness of children's understanding was tested by introducing a different new type of irrelevant information. This time, as well as verbally mentioning irrelevant information to the children in the complex test question, irrelevant information was included in the array of items. This additional irrelevant information concerned the different and shared features of the items used in the task. In a standard aspectuality task the irrelevant information in the array is the modality that the items share (e.g., two items that are both soft),whereas the relevant information is the modality that makes the items different (e.g., one is red and one is blue). Children who understand aspectuality focus on the latter: they understand how the items differ. When the items are hidden and they are asked to find one of them they realise that it is how the items differ that is important.

The current experiment investigated children's ability to recognise how the items differed. It aimed to assess their understanding of what information was important and what information was irrelevant and could be disregarded. This was done by presenting an array of items where one modality (e.g., colour) would offer some differentiation between the items, but not enough to differentiate them completely. This modality would be irrelevant. The other modality (e.g., feel) would offer full differentiation (FD) and be relevant.

In Experiment 3, therefore, partially differentiating (PD) trials were introduced. They consisted of an array of four items as such manipulations were not possible with the two item task used in previous experiments. In the four item array one modality would offer partial differentiation (e.g., two red and two blue) and the other would offer full differentiation (e.g., all feel different). The intention was to compare children's ability to deal with this type of information with the type of trial that they could succeed at: the type used in Experiment 2 where the items only differed in one perceptual modality. Hence, children's performance on standard trials with two items and full differentiation was compared against their performance with four items (and PD). Children who had a robust understanding of aspectuality would have no difficulty dealing with the PD trials. If children did find the PD trials more difficult then further investigations would be needed to ensure that this was not caused by the increase in the number of items.

The findings from Experiment 2 suggested that 4 to 5-year-olds had no difficulty with the complex question. However, due to the feeling bias found in Experiment 2, it was necessary to continue the investigations concerning young children's ability to deal with irrelevant information. Thus, Experiment 3 aimed to investigate whether children demonstrated a robust understanding of aspectuality by assessing their performance with the complex question type and the inclusion of the PD information. The apparatus was changed from bags back to tunnels to bring the equipment more in line with that used in the existing research (e.g., O'Neill et al., 1992) and to attempt to remove the bias towards feeling that was found in Experiment 2.

2.1 *Method*

Participants

One hundred and eighty four children participated from two schools serving predominately working class populations in Birmingham, U.K. Ninety-two 5-year-olds (range 5;3 to 6;2, mean 5 years and 9 months; 49 girls) and 92 6-year-olds (range 6;3 to 7;2, mean 6 years and 8 months; 53 girls) participated. They were all reported by their teachers as possessing a good understanding of English. The ethnicity of the children was distributed as follows: Asian (95), White (68), other (13), and Black (8).

Materials

The sixteen target items were 7cm diameter balls, as described in Experiment 2. Additionally, in the familiarisation task, an orange ball that contained a hollow hard cardboard sphere was used. To attempt to reduce the feeling bias found in Experiment 2 and to facilitate a direct comparison with existing research, the tunnel apparatus from Experiment 1 was used. Therefore, the remainder of the materials consisted of four identical grey tunnels, an opaque cloth, and an opaque bag.

Design

As in Experiment 1 children were familiarised with the equipment and then went straight on to their experimental trials. Children in the two age ranges were allocated in turn to one of the following four conditions: FD/simple question; FD/complex question; PD/simple question; PD/complex question.

The simple and complex question types were the same as used in Experiment 2. The FD trials had only one differentiating modality (e.g., two balls that were red but they felt different). The PD trials had a partially differentiating (PD) secondary modality (e.g., four balls that all felt different but two were red and two were blue). The looking and feeling trials were arranged to give four fixed orders of presentation; the same as those used in Experiment 2.

Procedure

Familiarisation. The findings from Experiment 2 showed that practice trials did not improve children's performance or reduce modality bias. In Experiment 1 it was clear that 5 to 6-year-olds performed well above what would be expected by chance without practice trials. Therefore, in the current study children were not given practice trials and were familiarised with the tunnels as in Experiment 1.

Children were told that the real game was going to begin soon and the other tunnel(s) was/were brought out and stacked underneath the original one. The tunnels formed a tower, so that all the windows were on one end and all the feeling holes on the other end. The experimenter then explained that, "for every go of the game I'm going to hide two/four balls, one in each of the tunnels and then I'm going to ask you to find one of them for me. You have to decide what you want to do to find it and you'll only be allowed to do one thing, so you have to decide whether you want to look through the windows or whether you want to feel through the holes". As in Experiment 1 and in all subsequent studies children's understanding of the difference between the two modes of access was checked.

Main trials. Before every trial the children were presented with the balls that were going to be used in that trial and asked to make sure that they looked at them and felt them, whilst the experimenter described the perceptual attributes of each ball in turn, for example, "this one is red and heavy". The descriptions were carried out in a predetermined and counterbalanced order for each trial, with the modality that distinguished the target item always mentioned first.

After the children had examined the balls, they were hidden in the tunnels in a predetermined order, so that the target item's position varied in the tower. This took place underneath the cloth so that the children could not see. The children were then asked to find the target item with a question type (simple or complex) determined by the experimental condition that they had been allocated to. For example, children that were given the simple question were asked to "find the red one", whereas children that were given the complex question were asked to find the "red heavy one".

The children's responses were noted and they carried out their chosen action. They were then asked to indicate to the experimenter which tunnel they thought contained the target item. They were not permitted to carry out the alternative action. The ball was retrieved from the tunnel chosen and passed to the child, but no correction or feedback was offered by the experimenter. The remaining balls were removed from the tunnels and the chosen ball retrieved from the child before the next trial was started. At the end of their trials children were rewarded with a sticker.[4]

2.2 *Results*

Coding

All children passed the familiarisation task and so took part in the main experiment. Children were given a score of 1 for every correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 3).

Analysis

A repeated-measures ANOVA was carried out with question type (simple and complex), array type (FD and PD) and age (5-year-olds and 6-year-olds) as between subject factors and modality (looking trials and. feeling trials) as a within subject factor. The results showed a main effect of modality, $F(1, 176) = 10.30$, $p = .002$, $\eta^2_p = .06$. Children performed better on the looking trials ($M = 1.40$, $SD = .68$) than on the feeling trials ($M = 1.18$, $SD = .70$). There was an interaction between modality and array type, $F(1, 176) = 4.47$, $p = .036$, $\eta^2_p = .03$. Paired sample post hoc *t* tests (making a Bonferroni correction for 4 tests, $p < .0125$) revealed that children who received PD trials performed better on their looking trials ($M = 1.42$, $SD = .68$) than feeling trials ($M = 1.05$, $SD = .72$), $t(91) = 3.43$, $p = .001$, $r = .34$. There was no effect of question type, array type, age or any other interaction (highest $F = 3.52$, lowest $p = .062$, indicating that an interaction between age and question type approached significance and suggesting that 6-year-olds who received the complex

[4] The procedure following children's responses to the test question was repeated in all subsequent experiments

Table 3

Number of trials answered correctly in Experiment 3

Question Type	Item number	Number of trials correct 0	1	2	3	4	Mean (Standard Deviation)
Simple	2 (*n*= 46)	0	4	16	14	12	2.74 (.95) ***
	4 (*n*= 46)	1	6	16	10	13	2.61 (1.11) **
Complex	2 (*n*= 46)	0	4	21	14	7	2.52 (.86) ***
	4 (*n*= 46)	2	4	20	12	8	2.43 (1.03) **
Expected frequencies if performance were at chance (n= 46)		*2.875*	*11.5*	*17.25*	*11.5*	*2.875*	*2*

question performed less well than those who received the simple question). Analysis was then carried out to see if children's performance improved over time. Paired-sample *t* tests showed no difference in any condition between performance on the first two trials and performance on the last two trials (lowest p = .09).

Finally, individuals' observed scores were compared to chance. Analysis showed that children who received the simple question with FD performed better than would be expected by chance, χ^2 (4, N = 46) = 37.36, p < .001, as did those who received the simple question with PD, χ^2 (4, N = 46) = 15.04, p = .005. Children who received the complex question with FD also performed better than would be expected by chance, χ^2 (4, N = 46) = 39.80, p < .001, as did those who received the complex question with PD, χ^2 (4, N = 46) = 14.75, p = .005.

2.3 *Discussion*

The results of Experiment 3 showed that the presence of irrelevant information in the complex question had no effect on children's performance. That is, there was no difference between performance with the complex question and performance with the simple question. These results replicate the findings of Experiment 2. Children aged 5 and 6 years of age were able to deal with irrelevant information that was included in the test question.

No difference in performance was found between the two age groups. Five-year-olds performed just as well overall as 6-year-olds. However, it is also of interest to compare children's performance on the FD trials in the current experiment to children's performance in Experiment 2. They were functionally equivalent in that both used a FD location task with simple and complex questions, but differed in the ages of the children tested. The mean scores from the FD trials in the current experiment showed that 5 and 6-year-old's performance was identical to each other (both M = 2.67, SD = 1.03), and very close to the mean scores from the 4 to 5-year-olds that were tested in Experiment 2 (M = 2.63, SD = 1.09). This suggests that children's performance did not improve between the ages of 4 and 6 years. This is in contrast to many suggestions in the literature that young children's understanding of aspectuality gradually develops up until the ages of 5 or 6 years, or even higher (e.g., Naito, 2003: O'Neill et al., 1992; Perner, 1991).

Despite no differences between the age groups or question types, children in Experiment 3 performed much better in their looking trials than in their feeling trials. Post-hoc analysis showed that this main effect of modality was driven by the array type. Although there was no main effect of array type, children's performance on PD feeling trials was at chance level. Performance on all other feeling and looking trials was significantly above what would be expected by chance.

As previously mentioned, existing research has revealed tendencies for children to prefer one form of perceptual access to another, but has not shown any fixed pattern to or explanation for this behaviour, especially in older age groups (e.g., O'Neill et al., 1992; Pillow, 1993). Initially it was thought that the change in apparatus from bags back to tunnels may have been responsible for the difference in modality bias between Experiments 2 and 3. However, no bias was found when the tunnels were used in Experiment 1. It is possible that some school classes had focussed on particular perceptual modalities in lessons during the period prior to the current experiments being run. This may have influenced children's tendency to prefer one mode of access over another. Nevertheless, the reason for such biases has yet to be established.

Taking into account the bias towards looking, the comparison carried out between observed and expected frequencies suggested that some children had a tendency to perform less well on the four object trials. It is possible that these children found the PD array slightly more difficult because of the PD information that was included. That is, the presence of this irrelevant information in this format may have caused the children some problems understanding what information would be gained from what access. There is an alternative possibility, however. Children might have found the PD trials more difficult due to the increase in the number of items presented in the array. There were four balls in the PD trials and only 2 balls in the ND trials. This larger array combined with the preference towards looking could have caused problems for children's working memory. There is evidence to suggest that the central executive in working memory is limited in that it can maintain either storage, or enable processing, but has difficulty allowing both to happen at the same time (e.g., Daneman & Carpenter, 1980; Just & Carpenter, 1992). Therefore, an increase in complex information in the present study could have increased the need for storage, but reduced the ability to focus on the test question and the appropriate answer. This complex information could be either the increase in the array or the PD information. Therefore, a further experiment was needed to further investigate whether it was an increase in the number of items, or the inclusion of PD information that influenced children's performance.

3. Experiment 4 – Young children's ability to ignore irrelevant partially differentiating perceptual information

This experiment was designed to clarify whether young children were able to ignore irrelevant information that was included in the array of items (PD information). A four item PD condition was compared to a condition that used four items but included no PD information (ND). For example, in PD looking trials there could be four balls that were all different colours (so colour gave full differentiation) but two were hard and two were soft (so feel gave partial differentiation); for PD feeling trials the balls would all feel different but two were red and two were blue. In contrast, in ND looking trials there could be four balls that were all different colours but would all feel the same; for ND feeling trials the balls would all feel different but look the same. Any difference found in performance would therefore be due to the PD information rather than the number of balls in the array. The results of Experiment 3 showed no difference in performance between 5 and 6-year-olds, so in Experiment 4 a group of children whose ages ranged between 5 and 6 years were tested.

3.1 *Method*

Materials

The materials from Experiment 3 were used.

Participants

Thirty-two 5 to 6-year-olds participated from a school that served a predominately working class population in Birmingham, U.K. Their ages ranged from 5;10 to 6;9 (mean 6 years and 4 months; 9 girls – the smaller proportion of female participants was representative of the school's intake that year). They were all reported by their teachers as possessing a good understanding of English. The ethnicity of the children was distributed as follows: White (26), Asian (2), Black (2) and other (2).

Design

Each child received eight trials, four where PD information was present and four where ND information was present. Each child received four trials where the target modality was colour (2 x PD and 2 x ND) and four trials where the target modality was tactile (2 x PD and 2 x ND). These trials were presented in one of the four fixed orders

(FLFLFLFL or LFLFLFLF or FLLFLFFL or LFFLFLLF) with PD and ND trials alternating within those orders.

Procedure

The same familiarisation process was used from Experiment 3. The main trials were the same as in the simple question condition used in Experiments 2 and 3 (that is, children were asked to find the target item using only the relevant modality, e.g., “find the red one”).

3.2 *Results*

Coding

All children passed the familiarisation task and so took part in the main experiment. Children were given a score of 1 for every correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 4).

Analysis

A repeated-measures ANOVA was carried out with modality (looking trials and feeling trials) and information type (PD and ND) as within subject factors. The results showed a main effect of information type, $F(1, 31) = 8.75$, $p = .006$, $\eta^2_p = .22$. Children performed better on the ND trials (($M = 3.00$, $SD = .88$) than on the PD trials ($M = 2.47$, $SD = 1.11$). No effect of modality and no interactions were found (highest $F = 2.97$, lowest $p = .10$). As there were twice as many trials in Experiment 4 as in Experiment 2 (where a feeling bias was apparent) and Experiment 3 (where a looking bias was apparent), further investigation was carried out. When only the first four trials were considered, a preference was found for looking ($M = .77$, $SD = .28$) over feeling ($M = .56$, $SD = .35$), $t(31) = 2.88$, $p = .007$, $r = .46$, replicating the bias found in Experiment 3.

Table 4

Number of trials answered correctly in Experiment 4

Trial Type	Number of trials correct					Mean
	0	1	2	3	4	(Standard Deviation)
Partial Differentiation (*n* = 32)	1	5	11	8	7	2.47 (1.11) **
No Differentiation (*n* = 32)	0	1	9	11	11	3.00 (.88) ***
Expected frequencies if performance were at chance (n = 32)	*2*	*8*	*12*	*8*	*2*	*2*

Analysis was then carried out to see if children's performance improved over time. Paired-sample t tests showed that children performed no differently in their first two ND trials (M = 1.47, SD = .57) to their last two ND trials (M = 1.56, SD = .50), $t(31) = -.83$, p = .41, r = .15. Also, children performed no differently in their first two PD trials (M = 1.19, SD = .74) to their last two PD trials (M = 1.28, SD = .63), $t(31) = -.65$, p = .52, r = .12.

Finally, individuals' observed scores were compared to chance. Analysis showed that, for the PD array, children performed better than would be expected by chance, χ^2 (4, N = 32) = 14.21, p = .007, as they also did for the ND array, χ^2 (4, N = 32) = 50.50, p < .001.

3.3 *Discussion*

Children's performance was better in the ND trials than in the PD trials. They were more successful at choosing the correct perceptual access to find a target when they had an array of items offering no secondary modality differentiation, than when the array included a partially differentiating secondary modality. In other words, children's difficulty was in dealing with irrelevant information included in the array, rather than due to more items being used in the tasks. They performed well above chance with the four item array when irrelevant information was not included.

The results demonstrate that 5 to 6-year-olds are able to succeed at a task assessing aspectuality, even when that task uses four items, but that their understanding is not robust. Children did not treat the partially differentiating information in the array of items as irrelevant information. They appeared not to realise that it was not helpful to their decision as to what perceptual action to take to find, for example, the red item.

4. Discussion of Experiments 2, 3, and 4

The experiments in this chapter aimed to clarify not only when young children understand aspectuality, but also how robust this understanding was. This was done by examining their ability to deal with irrelevant information. The findings of Experiment 2 showed that 4 to 5-year-old children were able to ignore irrelevant perceptual information in the test question. In Experiment 3, 5 and 6-year-olds were also not affected by the presence of irrelevant information in the test question. The children tested in Experiment 3 did, however, experience problems dealing with an array of items that included irrelevant PD information. The results of Experiment 4 clarified that this difficulty was caused by the irrelevant PD information and not by the increase in the number of items used in this task.

The results from this chapter raise two important points. The first point is how an understanding of aspectuality can be hindered and why. Many researchers (e.g., O'Neill et al., 1992; Perner, 1991; Perner & Ruffman, 1995) have suggested that it is not until 5 or 6 years of age that children understand aspectuality, but have based these proposals on basic tasks. They had given the impression that when children could pass an aspectuality task their understanding was complete. However, it was not known how much children who could pass these tasks really understood. The robustness of their understanding of aspectuality had not been investigated. The complex question and PD information in the current experiments enabled a much more in-depth assessment of young children's understanding of aspectuality, by including irrelevant information in the tasks and testing when children show a robust understanding.

The findings from this chapter allow a re-assessment of what constitutes an understanding of aspectuality and how this understanding can be tested. It is now apparent that 4 to 5-year-olds can pass a standard aspectuality task, contrary to suggestions made in the literature (e.g., Naito, 2003; Perner & Ruffman, 1995) and yet even 6-year-old children's understanding of aspectuality cannot be described as robust. Although children from 4 years of age were not affected by the complex question, even those aged 6 years had problems with the PD information. The ability to deal with the complex question information shows some ability to identify the relevant information, but the argument here is that a robust understanding should also allow children to ignore irrelevant information in the array of items presented.

It is possible that the two types of irrelevant information used in the current experiments (verbal descriptions in the complex question and the items themselves in the PD trials) were assessing different abilities. O'Neill et al. (1992) suggested that 5 to 6-year-old children are starting to think like adults about evidence and how that evidence relates to the modality specific aspects of knowledge. In other words, children of this age should understand that in order to gain knowledge the supporting evidence must be unambiguous. However, evidence can vary in significance and may require different processes of evaluation. In the current experiments the evidence in the complex question and PD information conditions differed to some extent. In the complex question, the critical evidence was the sole differentiating factor between the FD and this factor had to be recognised during children's experience of the items before they were hidden (due to the content of the question). For example, children had to recognise the relevance that the items differed only by colour, because both the colour and feel were mentioned in the test question.

In the PD trials, however, the critical evidence was the entirely (not partially) differentiating factor that could be discovered during the pre-trial experience. For example, children had to recognise the relevance that the items only completely differed by colour, and that those other differences were irrelevant. So, the irrelevant factor in the PD condition causes difficulty because it competes as a potential source of evidence. Research investigating young children's ability to evaluate evidence suggests that 5-year-olds might be able to encode evidence, but can have difficulty interpreting and using this evidence to justify a knowledge state (Fay & Klahr, 1996). If children have more difficulty evaluating this type of PD evidence and understanding what it means, then maybe they do not think about evidence in the way that adults do.

The second point raised by the current findings regards children's understanding of the test question. It appears to be contradictory. On one hand, children performed surprisingly well when they were given the complex question. They understood that only one feature was relevant when they were asked to find the "red heavy one". They were not distracted by the presence of the irrelevant information in the question. On the other hand, children did not seem to understand the relevance of the information in the simple test question. They did not realise that this information could lead them to the correct response (looking or feeling). For example, if children were confused by the irrelevant PD information in the array in Experiment 4, they could have simply considered the question they were asked to, "Find the red one".

When asked to find "the red one", why did children not realise that the only action that would tell them that information was looking and that they did not need to remember the array? It is possible that they believed they had to recall their experience of the items to succeed at the task. This belief was so strong that it disrupted their realisation that they could succeed at the task by just listening to the information in the test question. Further investigation is required to determine what young children understand about relevant information included in these tasks. Nevertheless, what this does demonstrate is that it is not necessary to have any perceptual contact with the items at all to be able to succeed at some aspectuality tasks. You do not need to see an item beforehand to understand that you will need to look to find out if it is red.

In the introduction to this thesis it was suggested that to have a robust understanding of aspectuality required being able to cope effectively with changes and variations. A robust understanding of aspectuality means that your comprehension of the link between perception and knowledge can deal with the unexpected. It is also possible that one of the features of a robust understanding of aspectuality is being able to hold in mind what is relevant or important. Therefore, when information is more complex, it is increasingly difficult to hold that information in mind. It may have been that in Experiment 4 children were attempting to remember the perceptual qualities of the items, even though no recall of the items was actually required to succeed at the task. After all, in real-world situations we most probably try to remember all potentially relevant information, especially if we are unsure of any future need for that information. While children could succeed at this task by making a simple association between, for example, colour and looking, they could have found it more difficult to recall the more complex perceptual information in the PD array.

There are suggestions in the existing literature that young children can have difficulty recalling information they have experienced. In fact, Perner and Ruffman (1995) suggest that 6-year-old's increasingly advanced ability to remember experienced events underpins their understanding of aspectuality. They found a significant correlation between performance on aspectuality tasks and performance on free recall tasks (where children had to recall, unprompted, some pictures that they had previously been shown). It does seem that being able to remember when and how you found out information may be a pre-requisite for being able to understand how you can find out further information. The current data suggest that children's memory deficits may limit their ability to demonstrate understanding of aspectuality (see the General Discussion). Children seemed to have some difficulty in recognising and holding in mind what information was useful to them in the current task. It appears that it is being able to remember the relevant information, rather than the overall event, that is important for a robust understanding of aspectuality. Further investigation is required to determine why children have difficulty in recognising and processing certain information that is relevant to their understanding of aspectuality.

In summary, the results of Experiments 2, 3, and 4 suggest that 4 to 5-year-old children show some understanding of aspectuality, using the criteria suggested by the existing literature. However, it is proposed that a robust comprehension of aspectuality is not apparent until over 6 years of age, that is, older than the children tested in the current experiments. The findings from this chapter demonstrated that young children possessed a somewhat surprising ability to deal with irrelevant verbal descriptions included in the test question. This ability suggests that children had already understood how the balls differed and what perceptual action they needed to take before the test question had been asked. This means that they had gained awareness of the similarities and differences between the balls through their experience of them during the familiarisation procedure. The next chapter investigated this matter further by focusing on the way the perceptual qualities of the balls were introduced during familiarisation.

CHAPTER 4 – THE EFFECT OF EXPERIENCE ON YOUNG CHILDREN'S PERFORMANCE IN ASPECTUALITY TASKS

Experience is generally considered to be a positive thing. We tend to think that if you possess experience then you are more likely to have increased knowledge, to be more skilled and to show better performance. It is possible to have different types of experience, for example, being familiar with a procedure, or having had practice at carrying out an action. Being experienced at something means that your understanding of it is robust. If you are familiar with an action then you are more likely to be able to resist variations or changes that affect it. However, experience does not always need to be direct: first-hand experience involves a person witnessing or taking part in an event whereas second-hand experience involves gathering information from others. Even young children can benefit from having second-hand experience, for example, by having knowledge about an event before it happens (e.g., Sutherland, Pipe, Schick, Murray, & Gobbo, 2003). However, having experience of the items beforehand has been suggested as having a negative effect on young children's performance in aspectuality tasks (Perner & Ruffman, 1995). The current experiment aimed to clarify whether particular types of prior experience might have an influence on young children's performance in aspectuality tasks, and so reveal more about the robustness of their understanding.

The effect of prior experience on young children's cognitive abilities has been the subject of much research (e.g., Conroy & Salmon, 2006; Gobbo, Mega, & Pipe, 2002). It has tended to focus on how previous experience affects children's ability to remember the details of an event. For example, Sutherland et al. (2003) demonstrated how receiving relevant information beforehand increased 5 to 7-year-olds' subsequent recall of a novel event. Children were either read a detailed story about what would happen when they "visited a pirate" the following day, or took part in a related, or non-related, discussion. Those who were given the most relevant experience (the story) showed better recall of the visit, both one day and four months later. Overall, it is suggested that prior experience assists in young children's retention of knowledge, although the benefit of different types of experience can vary.

In contrast, Perner and Ruffman (1995) propose that giving children prior experience may not help them succeed at aspectuality tasks. As previously mentioned, in aspectuality tasks, children are typically presented with two items that share one perceptual aspect, but are different in another. For example, they might feel identical, but differ in colour. When one or both are hidden, children have to decide whether they need to feel or look to find out particular perceptual information. What is important here is that giving children prior experience of the items in this task is intended to help them. It is supposed to make them more aware of the differences and similarities between the items and make it easier for them to choose the correct perceptual action when asked (e.g., O'Neill et al., 1992; Pillow, 1993; Robinson et al., 1997). Yet it is this pre-trial experience that has been implied by Perner and Ruffman (1995) as being detrimental to children's performance.

Perner and Ruffman (1995) introduced a different version of the aspectuality task that demonstrated how pre-trial experience might influence performance. They designed the task primarily to obtain a more sensitive measure of children's understanding. In this new task children did not have any experience of the items prior to their trials. Instead, one item was hidden (out of their sight) and children were asked whether they would like to look or feel to find out whether it was, for example, black or white. Children found this "one item" task considerably easier than the traditional "two item" task in a direct comparison (although see Chapters 5 & 6 of this thesis regarding the impact of the differences in question phrasing in these two tasks). Perner and Ruffman (1995) suggested that this was because in the two item task children attempt to remember their pre-trial experience. They have difficulty encoding this experience and this then disrupts their performance in the task.

One point of view then is that prior experience is beneficial, although some types of experience may be more useful than others. For example, Murachver, Pipe, Gordon, Owens, and Fivush (1996) gave 5 and 6-year-olds experience of a novel event. Children who directly experienced the event themselves showed better recall than those who watched another child taking part, or listened to a story about a child taking part. Also, McGuigan and Salmon (2005) showed how combining particular relevant information (e.g., pictures and narration) prior to a trip to a pretend zoo improved 5 and 6-year-olds later recall of the event. Offering pictures, narration and other types of information (e.g., written goals or labels) independently did not improve recall.

A second point of view, in the aspectuality literature, is that prior experience cause's children difficulty (Perner & Ruffman, 1995). However, in this view there has been no suggestion regarding particular types of experience and any influence they might have on children's performance. The first aim in the current experiment, therefore, was to clarify whether young children have difficulty dealing with prior experience of the items hidden in aspectuality tasks, or whether they find it beneficial. The second aim was to find out whether the type of prior experience children receive in these tasks affects their performance on the task.

1. Experiment 5 – Is young children's performance on aspectuality tasks influenced by the type of pre-trial experience they are given?

In tasks assessing aspectuality understanding, a standard procedure is typically followed regarding children's pre-trial experience (see Experiments 1 to 4; O'Neill et al., 1992; Perner & Ruffman, 1995). In this pre-trial experience children are allowed to look at and feel the items before they are hidden. Also the perceptual qualities of the items are pointed out by the experimenter: For example, the experimenter will state that one item is red and one is blue but both are soft. Children's pre-trial experience of the items can therefore be easily separated in two distinct categories: the self accessed experience that they gain through looking at and feeling the items and the verbally accessed experience that they gain from being told about the perceptual qualities of the items by the experimenter. Experiment 5 investigated whether these types of experience influenced children's performance.

1.1 *Method*

Participants

One hundred children (49 girls) participated from two schools serving predominately working class populations in Birmingham, U.K. Their ages ranged from 5;10 to 7;2 (mean 6 years and 5 months) and they were all reported by their teachers as possessing a good understanding of English. Ethnicity was distributed as follows: White (53), Asian (37), Black (4) and other (6).

Materials

The materials from Experiment 1, 3, and 4 were used.

		Verbally Accessed Experience	
		✗	✓
Self Accessed Experience	✗	No Experience (13 girls, 12 boys; age range 5:10 to 7;2)	Verbal Experience (10 girls, 15 boys; age range 5:10 to 7;2)
	✓	Self Experience (14 girls, 11 boys; age range 5:10 to 7;1)	Combined Experience (12 girls, 13 boys; age range 5:10 to 7;0)

Figure 2

Factors and conditions used in Experiment 5

Design

A location version of the aspectuality task was used, where two items were hidden in two tunnels. Children were familiarized with the equipment and were then given eight experimental trials. The factors of self accessed information and verbally accessed information were manipulated to create four separate conditions: including one, both or neither of the factors (see Figure 2). Therefore, children were allocated in turn to one of the following four conditions: no experience; verbal experience; self experience; combined experience. The looking and feeling trials were arranged to give two fixed orders of presentation: Look, Feel, Feel, Look, Feel, Look, Look, Feel (LFFLFLLF); FLLFLFFL.

Procedure

Familiarisation. The familiarisation procedure was the same as Experiment 1.

Main trials. Prior to each trial children were given the appropriate experience determined by their allocated condition. In the no experience condition the balls for each trial were hidden directly in the two tunnels, without any description by the experimenter and without the children having access to them. The children were just told that two balls would be hidden. In the verbal experience condition the experimenter described the colours and feels of the balls before they were hidden, but the children had no direct perceptual access. For example, 'I'm going to hide two balls, one is hard and blue and the other is soft and blue'. The descriptions were carried out in a predetermined and counterbalanced order for each trial, with the modality that distinguished the target always mentioned first. In the self experience condition no verbal description was offered, the children were told that two balls would be hidden while the experimenter put the balls on the table in front of them and encouraged them to look at them and feel them. In the combined experience condition the experimenter described the perceptual qualities of the balls for that trial (as in the verbal experience condition) and encouraged the children to look at them and feel them (as in the self experience condition).

The two balls were then hidden, one in each tunnel, underneath the cloth so that the children could not see. The children were then asked to find the target (using the simple question format). The remainder of the procedure was carried as in Experiments 1 to 4.

1.2 *Results*

Scoring

All children passed the familiarisation task and so took part in the main experiment. Children were given a score of 1 for every correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 5).

Analysis

A repeated-measures ANOVA was carried out with verbal information type (verbally accessed information and no verbally accessed information) and self information type (self accessed information and no self accessed information) as between subject factors and modality (looking trials and feeling trials) as a within subject factor. The results showed a main effect of verbal information type: Children who received no verbally accessed information (M = 6.44, SD = 1.53) performed better than those who received verbally accessed information (M = 5.58, SD = 1.54), F(1, 96) = 7.87, p = .006, η^2_p = .08. No other effects were found (highest F = 1.88, lowest p = .17).

In order to directly compare the current findings with the aspectuality literature (where combined experience is most commonly used) a repeated-measures ANOVA was carried out with information condition (no experience; verbal experience; self experience; and combined experience) as a between subject factor and modality (looking trials and feeling trials) as a within subject factor.

Table 5

Number of trials answered correctly in Experiment 5

Information Condition	Number of trials correct									Mean (Standard Deviation)
	0	1	2	3	4	5	6	7	8	
No Experience (*n*= 25)	0	0	0	2	3	3	4	7	6	6.16 (1.63) ***
Verbal Experience (*n*= 25)	0	0	1	2	3	7	5	5	2	5.44 (1.56) ***
Self Experience (*n*= 25)	0	0	0	1	1	2	6	5	10	6.72 (1.40) ***
Combined Experience (*n*= 25)	0	0	1	1	2	7	7	3	4	5.72 (1.54) ***
Expected frequencies if performance	*.0975*	*.775*	*2.75*	*5.5*	*6.75*	*5.5*	*2.75*	*.775*	*.0975*	*4*

The results showed a main effect of information condition, $F(3, 96) = 3.32$, $p = .023$ $\eta^2_p = .09$. Independent-samples *t* tests showed that children in the self experience condition ($M = 6.72$, $SD = 1.40$) performed better than those in the verbal experience condition ($M = 5.44$, $SD = 1.56$), $t(48) = -3.06$, $p = .004$, $r = .40$, and better than those in the combined experience condition ($M = 5.72$, $SD = 1.54$), $t(48) = 2.40$, $p = .02$, $r = .33$. Children in the no experience condition ($M = 6.16$, $SD = 1.63$) performed no different to children in any other condition. There was no effect for modality and no interactions were found (highest $F = .60$, lowest $p = .62$).

Analysis was then carried out to see if children's performance improved over time. Paired-sample *t* tests showed that children performed no differently in their first four trials, compared to their last four trials in any condition (lowest $p = .14$).

Finally, individuals' observed scores were compared to chance. Analysis showed that in every condition children performed better than would be expected by chance: no experience, $\chi^2(8, N = 25) = 416.88$, $p < .001$; verbal experience, $\chi^2(8, N = 25) = 68.69$, $p < .001$; self experience, $\chi^2(8, N = 25) = 1046.83$, $p < .001$; combined experience, $\chi^2(8, N = 25) = 178.54$, $p < .001$.

1.3 *Discussion*

This experiment aimed to test two hypotheses. The first was proposed by Perner and Ruffman (1995) who suggested that young children performed worse at aspectuality tasks when they had pre-trial experience of the items. The second was implied by the event memory literature which suggested that the type of pre-trial experience that children received influenced their performance.

With regard to the first hypothesis, when Perner and Ruffman (1995) removed the pre-trial experience from their experiment, they removed the whole experience. In other words, instead of assessing children's performance when they had received experience (which in effect was combined experience) they were assessing their performance when they had received none (no experience). They found that children performed better when they received no experience and concluded that (combined) experience caused children difficulty. The current findings do not support Perner and Ruffman's (1995) suggestion. No difference was found in performance between children who had received no experience and children who had received combined experience (or indeed any other type of experience). It is possible that testing more participants could increase the level of confidence (power) in these results and reveal a small effect that is currently undetectable. However, it is likely that such an effect would be much smaller than those that have been detected with the existing number of participants. With regard to the second hypothesis, the event literature proposed that the type of pre-event experience children received might have an important impact on their recall (e.g., Murachver et al., 1996). This was interpreted to suggest that the type of pre-trial experience given to children in aspectuality tasks might influence their performance. This proposal was upheld. Particular types of experience were found to have a significant effect on children's behaviour and these effects will now be discussed in turn.

First, the analysis of the four experimental conditions (self, verbal, combined, and no experience) will be assessed. Children who *only* received self experience performed better than those who received *only* verbal experience and better than those who received *both* (combined experience). At an initial glance, this implies that children perform best when they are allowed to experience the perceptual qualities of the items themselves; when they were shown the items and allowed to look and feel but the experimenter gave no descriptions. However, as stated before, children who had this type of experience were no more successful in the final task than children who had received no experience of the items at all. Finding out about the items by looking at them and feeling them did not help children.

So, how can the difference found between the four experimental conditions be explained? Children in the verbal experience and combined experience conditions showed the lowest performance. Children's performance in these conditions was not worse than receiving no experience at all, but was worse than receiving self experience. This means that children who were shown and told about the items, and children who were just told about them, performed worse than those who were just shown them. Being told about the items seemed to make the task more difficult.

The main analysis showed the full extent of this effect. By examining the influence of verbally accessed and self accessed information it was confirmed that children did not benefit from looking at and feeling the items. This is in contrast to Murachver et al.'s (1996) findings where direct prior experience gave better recall than more indirect methods. However, children's performance was adversely affected by the presence of verbal information. Children who were told about the items found the task harder. This means that telling children about the perceptual qualities of the items was the least effective way of transmitting the information to them. It had this effect when it was the only way that children found out about the items and when it accompanied them looking at and feeling the items.

This difficulty dealing with verbal descriptions of the items has never before been suggested in the aspectuality literature. Indeed there is little consideration of pre-trial experience at all. What does exist is based on combined experience of the items and focuses on children's episodic memory abilities. Perner and Ruffman's (1995) proposal that children found aspectuality tasks more difficult when they had received experience of the items, was based on their ability to recall information. Their theory relies on the concept that children attempt to remember the experience. When they are asked information about the target item they try to recall their previous experience; they try to remember how they had found out the perceptual qualities of the items. Perner and Ruffman (1995) suggest that until approximately 6 years of age, young children have a deficit in their episodic memory. They do not have the ability to recall events as having been experienced. They cannot remember looking at and feeling the items, and being told about them. When they are asked the test question they cannot remember how the items differed. If children are indeed attempting to recall their experience, then the findings from Experiment 5 suggest that it is the verbal description that is causing them problems. They did not seem to have difficulty recalling their self experience, but they may have had difficulty remembering what they have been told.

Research in other areas supports this idea that young children can have more difficulty remembering verbal information than other types of information. In the event literature there have been proposals that children recall less following verbal descriptions of an event. For example, Gobbo et al. (2002) found that 3 to 5-year-old children recalled less about an event (when asked immediately and a week later) if they had heard about it through a story, rather than when they had observed it, or participated in it directly. This suggests that children might find it harder to remember information they have been told, than information that had been gained in any other way.

However, some studies have shown that verbal experience is actually better than no experience at all. For example, McGuigan and Salmon (2005) gave 6-year-old children prior information about an event and then later asked them to recall details of that event. Children who had received prior narrative information recalled more about the event than those who had received no prior information at all (although those who received a combination of narration and photographs recalled the most).

Relevant verbal experience can, in some cases, even improve recall. For example, Sutherland et al. (2003) showed that 5 to 7-year-olds recalled most about an event when they had been given specific verbal information prior to the event occurring, rather than being given unspecific or irrelevant verbal information. Relevant verbal experience can provide children with appropriate labels and connections between factors that they would otherwise not possess (Sutherland et al., 2003).

In summary, the evidence regarding the advantages or disadvantages of verbal information to young children's recall is inconclusive. The effect of verbal information on young children's understanding of aspectuality has never been investigated. The subsequent experiment was designed to shed light on this matter. It aimed to confirm whether, in aspectuality tasks, children found dealing with verbal experience of the items harder than when they received no experience at all of the items. It also aimed to clarify whether children were attempting to recall the verbal descriptions of the items in this task. This was done by manipulating the quantity and relevance of the verbal descriptions they were given during their pre-trial experience.

2. Experiment 6 – The effect of verbal pre-trial experience on young children's understanding of aspectuality

It was possible that children found it difficult to remember the verbal descriptions of the perceptual qualities of the items that they received in Experiment 5. Evidence suggests that the development of young children's verbal working memory is related to their increasing ability to generate speech (Baddeley, 1986). Their capacity for articulatory rehearsal of information is also limited, especially before the age of 8 years (e.g., Kemps, De Rammelaere, & Desmet, 2000). This suggests that young children might find it difficult to hold verbal information in mind and recall what they have been told. Therefore, it was hypothesised that young children might find the current task easier if they had less to remember and, consequently, less to hold in mind. The manipulation in Experiment 6 involved reducing the number of descriptive words used to refer to the items in the pre-trial experience.

The way in which these words were reduced was easily determined. In Experiment 5 (and in previous aspectuality tasks), the items are described by referring to how they are the same and how they differ. For example, O'Neill et al. (1992) pointed out the perceptual quality that the items shared and then indicated how they differed. Nevertheless, to succeed at an aspectuality task it is only necessary for children to realise how the items differ. It is this difference that will determine what perceptual action they take later on in the task. For example, if the items are different colours then children should understand that they will need to look to locate one of them. There is other evidence to suggest that pointing out the relevant features helps with recall. For example, Conroy and Salmon (2006) suggested that young children's ability to remember an event improves if the relevant components are highlighted verbally. Also, verbal descriptions can be beneficial to 6-year-old children's recall, if those descriptions define the most relevant features (e.g., Bacharach, Carr, & Mehner, 1976; Olson 1970).

In Experiment 6, therefore, the number of descriptive words used was reduced by removing those that described how the items were the same. It was then possible to compare children's performance with three different quantities of verbal descriptions: none at all, just the relevant, differentiating modality information about the items, and all the visual and tactile information. The 6-year-olds tested in Experiment 5 performed well above chance in all conditions and this may have reduced the size of the effects that were found. For that reason, in Experiment 6 both 5 and 6-year-olds were tested.

2.1 *Method*

Participants

One hundred and sixteen children participated from three schools serving predominately working class populations in Leeds and Sheffield, U.K. Sixty-four 5-year-olds (range 4;10 to 5;11, mean 5 years and 5 months; 34 girls) and 52 6-year-olds (range 6;0 to 7;1, mean 6 years and 5 months; 26 girls) participated. They were all reported by their teachers as possessing a good understanding of English. Ethnicity was distributed as follows: White (86), Asian (24), Black (3), and other (3).

Materials

The materials from Experiment 1, 3, 4, and 5 were used.

Design

Children were given eight experimental trials. They were allocated in turn to one of the following three conditions: no experience; verbal experience; relevant experience.

Procedure

The procedure and the no experience and verbal experience conditions were the same as in Experiment 5. In the relevant experience condition the experimenter described only the differentiating factor between the two balls in each trial. For example, "I'm going to hide two balls, one is hard and the other is soft".

2.2 *Results*

Scoring

All children passed the familiarisation task and so took part in the main experiment. Children were given a score of 1 for every correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 6).

Analysis

A repeated-measures ANOVA was carried out with information condition (no experience and verbal experience and relevant experience) and age (5-year-olds and 6-year-olds) as between subject factors and modality (looking trials and. feeling trials) as a within subject factor. The results showed a main effect of age, $F(1, 110) = 15.56$, $p < .0001$, $\eta^2_p = .12$, with 6-year-olds ($M = 6.199$, $SD = 1.70$) performing better than 5-year-olds ($M = 4.95$, $SD = 1.82$). The results also showed a main effect of information condition, $F(2, 110) = 4.39$, $p = .015$, $\eta^2_p = .07$.

Table 6

Number of trials answered correctly in Experiment 6

Age and Information Condition	Number of trials correct								
	0	1	2	3	4	5	6	7	8
5-year-olds									
No Experience (*n* = 23)	0	0	0	1	5	4	4	4	5
Verbal Experience (*n* = 21)	0	1	0	7	3	6	2	2	0
Relevant Experience (*n* = 20)	0	0	2	5	5	3	0	2	3
6-year-olds									
No Experience (*n* = 17)	0	0	0	0	3	1	3	4	6
Verbal Experience (*n* = 17)	0	0	0	1	3	2	4	3	4
Relevant Experience (*n* = 18)	0	0	0	3	2	2	2	2	7
Expected frequencies if performance were at chance (n = 20)	*.078*	*.62*	*2.2*	*4.4*	*5.4*	*4.4*	*2.2*	*.62*	*.078*

Independent samples *t* tests showed that those in the no experience condition (*M* = 6.15, *SD* = 1.58) performed better than those in the verbal experience condition (*M* = 5.05, *SD* = 1.77), *t*(76) = 2.89, *p* = .005, *r* = .31 and better than those in the relevant experience condition (*M* = 5.29, *SD* = 2.09), *t*(76) = 2.06, *p* = .043, *r* = .23 No difference was found between the verbal experience (*M* = 5.05, *SD* = 1.77) and relevant experience conditions (*M* = 5.29, *SD* = 2.09), *t*(76) = -.53, *p* = .60, *r* = .06.

No interaction was found between age and condition, *F*(2, 110) = .92, *p* = .40, η^2_p = .016. However, independent samples *t* tests showed that 5-year-olds in the no experience condition (*M* = 5.87, *SD* = 1.60) performed better than those in the verbal experience condition (*M* = 4.29, *SD* = 1.52), *t*(42) = 3.53, *p* = .002, *r* = .48 and better than those in the relevant experience condition (*M* = 4.60, *SD* = 1.98), *t*(41) = 2.32, *p* = .025, *r* = .34. No difference was found between the verbal experience (*M* = 4.29, *SD* = 1.52) and relevant experience conditions (*M* = 4.60, *SD* = 1.98), *t*(39) = -.57, *p* = .57, *r* = .09. However, 6-year-olds in the no experience condition (*M* = 6.53, *SD* = 1.51) performed no different to those in the verbal experience condition (*M* = 6.00, *SD* = 1.62), *t*(32) = .99, *p* = .33, *r* = .17 and those in the relevant experience condition (*M* = 6.06, *SD* = 1.98), *t*(33) = .79, *p* = .43, *r* = .14. No difference was found between the verbal experience (*M* = 6.00, *SD* = 1.62) and relevant experience conditions (*M* = 6.06, *SD* = 1.98), *t*(33) = -.09, *p* = .93, *r* = .016.

Analysis was then carried out to see if children's performance improved over time. Paired-sample *t* tests showed that 5-year-olds performance did not improve from their first two trials to their last two trials in any condition. However, the performance of 6-year-olds in the verbal experience condition improved from their first two trials (M = 2.65, SD = 1.17) to their last two trials (M = 3.35, SD = .93), $t(17) = -2.14$, $p = .048$, $r = .46$.

Finally, individuals' observed scores were compared to chance. Analysis showed that 5-year-olds performed better than would be expected by chance in the no experience condition, $\chi^2 (8, N = 23) = 290.89$, $p < .001$, and the relevant experience condition, $\chi^2 (8, N = 20) = 115.98$, $p < .001$, but not the verbal experience condition, $\chi^2 (8, N = 21) = 8.40$, $p = .40$. Six-year-olds performed better than would be expected by chance in the no experience condition, $\chi^2 (8, N = 17) = 565.75$, $p < .001$, the relevant experience condition, $\chi^2 (8, N = 17) = 254.29$, $p < .001$ and the verbal experience condition, $\chi^2 (8, N = 18) = 695.27$, $p < .001$.

2.3 *Discussion*

Experiment 6 had three aims; first, was to confirm the findings from Experiment 5 that children had difficulty dealing with verbal descriptions. Second, was to find out if 5-year-olds performed any differently to 6-year-olds. The third aim was to examine whether reducing the amount of verbal information made the task easier for children. To begin with the first two points will be discussed.

The main analysis confirmed what was found in Experiment 5. Children had difficulty dealing with verbal information. However, the findings from Experiment 6 expanded on the previous results. The children tested in Experiment 6 performed overall much better when they were not given any experience of the items before they were hidden, offering some support to Perner and Ruffman's (1995) suggestion. However, why was this effect not found in Experiment 5? To answer this question it is necessary to look more closely at the performance of the different age groups in Experiment 6.

In the current study it was found that, overall, 6-year-olds performed better than 5-year-olds. However, 6-year-olds performed just as well when they received no experience as when they were told about the items (thus repeating the effect found with this age group in Experiment 5). In contrast, the 5-year-olds seemed to perform better when they had not received any experience of the items, than when they had been told about their perceptual qualities. Perner and Ruffman's (1995) third study also showed a marked difference between the performances of 5 and 6-year-olds. They found that children under 6 years of age performed better at an aspectuality task when they had not had experience of the items before they were hidden. However, it is important to remember that Perner and Ruffman (1995) believed that experience generally caused children's difficulty with the task, whereas the current findings have shown that only verbal experience was responsible.

This brings us to the third point, whether children had more difficulty with the task when they were told only the relevant perceptual information. The main analysis showed no difference in performance between the verbal experience and relevant experience conditions. Children performed the same whether they were just given the differentiating perceptual information about the items, or given all the perceptual information. They did not find the task easier when they had less information to deal with. However, when individual children's performance was examined, a different story was told. When the pattern of responses was analysed, it was apparent that 5-year-olds performed poorly when they were told about all the items' perceptual qualities. So although no difference was found between the verbal experience and relevant experience conditions with this age group, their performance on the former was no better than would be expected by chance. However, further investigation is required to clarify whether there is any substantial effect between these two types of verbal experience.

It was also apparent that 6-year-olds started off performing poorly when they were given all the items' perceptual qualities. However, these older children improved towards the end of their trials (but note that this was the only occurrence in the experiments carried out for this thesis of children's performance improving as the task progressed). These results imply that including the non-differentiating information in the verbal item description may make the task harder for children. Nevertheless, these results do not conclusively suggest that children perform better if they have less verbal information to deal with.

What is particularly interesting is that even when 5-year-olds were given just the relevant verbal descriptions of the items, their performance was poor. For example, even when told that a red ball and a blue ball were going to be hidden, and then asked to find the red one, these children did not realise that they had to look. Even though the tactile quality of the balls was never mentioned, 5-year-olds often chose to feel when asked to find a ball of a particular colour. It seems unlikely that any confusion between perceptual modalities occurred as *the alternative modality was never mentioned*. These children's performance is also surprising as the results of Experiment 2 showed that 4 to 5-year-olds can correctly choose the necessary perceptual action to find a specific perceptual aspect. The findings of the current study show that 5-year-old's understanding of aspectuality can be disrupted by telling them about the relevant perceptual qualities of the items before they are hidden.

3. Discussion of Experiments 5 and 6

The two experiments reported here investigated whether prior experience affected, or was beneficial to, young children's performance in aspectuality tasks. The findings from Experiment 5 showed that pre-trial experience in the form of verbal descriptions hindered 6-year-old children's performance whereas pre-trial experience in the form of self-directed looking and feeling made no difference to their performance. The findings from Experiment 6 showed that 5-year-olds had difficulty with the task even when they were given only the relevant verbal descriptions of the differing qualities of the items.

In many ways, these results are contrary to the implications made in the event literature. For example, Murachver et al. (1996) suggested that children recalled the most about an event when they had taken part in it directly, rather than been told about it. However, it was found here that giving children the opportunity to take part in the pre-trial experience did not improve their performance at the task. They were no more successful at knowing whether they needed to look or feel to find one of the items when they had discovered the perceptual properties of the items themselves, by looking and feeling. Also, Gobbo et al. (2002) suggested that while verbal experience may not be the most effective at promoting accurate recall, it is better than nothing. However, once again, the current experiments found the opposite. Children who were told about the perceptual properties of the items performed worse than children who knew nothing about the items. Finally, Sutherland et al. (2003) suggested that if experience was relevant, then it should be beneficial to recall. Once more, the current findings do not match. It was found that giving children just the relevant verbal descriptions of the items did not help them with the task.

How do the current findings fit with the suggestion made by Perner and Ruffman (1995)? They found that children under 6-years of age found aspectuality tasks easier when they did not have any pre-trial experience. This is partially supported by the current findings where children did not perform better when they had received no experience of the items; they performed worse when they had been given verbal experience. Children found the task more difficult when they had been told about the perceptual qualities of the items by the experimenter. However, for the majority of researchers in the aspectuality field, pre-trial experience is given to children with the idea that it will help them. Pre-trial experience is intended to make it clear that the items are the same in one modality and different in another, and assist children in their later decision regarding what perceptual access they need to take (e.g., O'Neill et al., 1992). The results of the current experiments demonstrate that this pre-trial experience may actually be reducing children's performance levels on these tasks. To allow children to perform at their best at aspectuality tasks, it might be that verbal descriptions need to be removed from their pre-trial experience.

Why might children have difficulty dealing with this verbal experience? Perner and Ruffman (1995) had suggested that children under 6 years of age have difficulty with aspectuality tasks because they attempt, and fail, to recall their initial experience of the items. This suggests that if children had difficulty recalling the verbal descriptions they were given in Experiment 5, they may find it easier if they had to recall less information. However, in Experiment 6 it was shown that 5-year-olds still had difficulty dealing with just the relevant verbal descriptions of the items. Nevertheless, children's poor ability to deal with information they had been told might still be related to their memory abilities.

Performance on the aspectuality task (modality-specific task) has been correlated with the development of episodic memory (Perner, Kloo, & Gornik, 2007). These researchers refer to a distinction in episodic memory between remembering an event through direct perceptual contact (e.g., remembering seeing the colour of an item) and having knowledge of an event through indirect contact (e.g., being told the colour of an item). In the former state, one remembers taking part in the experience and seeing for oneself the colour, whereas in the latter state one might know the colour but does not recall the experience of actually finding out the colour because one did not learn the information in that way. This distinction is important with relation to children's attempt to re-experience the pre-trial experience in aspectuality tasks. Based on this suggestion, young children would have difficulty succeeding at an aspectuality task if their initial experience of the items was indirect. They would not be able to re-experience their pre-trial experience if they had been told about the items. This would explain why the children tested here (particularly the 5-year-olds in Experiment 6) found the task harder when their pre-trial experience had included verbal information. Verbal information might be useful in that it can transmit knowledge from one person to another, but in the case of aspectuality tasks it causes difficulty, as it does not facilitate the recall necessary for children to re-experience the event.

This introduces the next discussion point. Why do children attempt to recall the pre-trial experience at all? As touched upon in previous chapters of this thesis, children could actually succeed at the current task without remembering the items. Regardless of the type of experience they had received, they were asked the same question, for example, "Find the red one". Regardless of the type of experience they had received, all they had to do was to realise that to find something that was red they needed to look. This demonstrates the lack of robustness of young children's understanding of aspectuality. They did not realise that they could succeed at this task by making this simple association. It seems that young children do not always realise when experiences matter and must be recalled and when experiences are irrelevant and can be ignored.

It must be pointed out, however, that in the aspectuality literature the test question does not always refer to the specific aspect of the item. Rather than be asked to find, "the red one", children are sometimes asked to find out "which one" has been hidden. In this latter case, children *do* have to recall their pre-trial experience, as this is the only way that they will realise how the items differ. The next experiment focuses on these variations in the phrasing of the test question and the implications of their use.

The conclusion that can be made from the results of Experiments 5 and 6 is that young children do not always benefit from experience. Rather, in some situations, 5-year-olds can have enormous difficulty dealing with pre-trial verbal information, performing only at chance level. Based on Perner, Kloo, and Gornik's (2007) proposal, it is suggested that verbal experience might provide children with knowledge but it does not facilitate their ability to re-experience the initial event. Children find aspectuality tasks harder when they have been previously told about the perceptual qualities of the items. Giving children this verbal experience may even harm any benefits gained from direct perceptual experience. The way in which this information limits young children's performance on these tasks demonstrates that their understanding of aspectuality is not robust.

The findings from this chapter have shown that verbal descriptions of items could have a significant influence on children's performance in aspectuality tasks. The next consideration was whether other types of verbal information that tend to be used in aspectuality tasks might have a similar effect. It was apparent from the extant aspectuality literature that differences in verbal descriptions were not only found within the familiarisation procedure. As just mentioned, variations in the descriptions of the items in the test questions were used in these tasks. The following chapter focuses on whether young children’s understanding of aspectuality was robust enough to deal with such variations in the questions they were asked.

CHAPTER 5 – DOES YOUNG CHILDREN'S UNDERSTANDING OF ASPECTUALITY DEPEND ON THE PHRASING OF THE QUESTION?

Imagine you owned two pairs of socks that were identical but for their colour. Someone then asked you *what colour* socks you were wearing. What would you do? If you could not remember you would probably take a look to confirm the colour socks that you were wearing. What if you were asked whether you were wearing your *black* socks *or* your *blue* socks? Again, you would choose to look, as looking is the best way to check the colour of something. How about if you were asked *which* pair of socks you were wearing? Once again you would take a look to check which pair you had on. These examples demonstrate that as adults, we would understand that regardless of the way the question was phrased, the questioner was seeking the same information and the same action was required. We would recognise that colour can best be determined by looking and that other perceptual actions would be of no use. This chapter investigated whether young children's understanding of the link between perceptual access and subsequent knowledge was sufficiently robust to deal with such differences in question phrasing.

As shown in the earlier chapters, young children's understanding of aspectuality is typically investigated by asking them to choose the perceptual action necessary to find out specific information about a hidden item (e.g., O'Neill et al., 1992). However, the tasks reported to date are remarkably inconsistent in the test questions they have asked children. Three different types of question have been used. First, children have been asked to find out "which one" has been hidden (e.g., O'Neill et al., 1992; Perner & Ruffman, 1995). Second, children have been asked to find out, for example, "what colour" item has been hidden (e.g., O'Neill et al., 1992; Pillow, 1993). Third, children have been asked to find out whether the hidden item is, for example "the red one" (O'Neill et al., 1992; Perner & Ruffman, 1995; Pillow, 1993). These question types will be referred to in this thesis as, respectively, the identity, dimension, and aspect questions. In some cases more than one of these references has been used in the same question. For example, Robinson and Whitcombe (2003) referred to both the identity and aspect of the target. They hid one of a pair of ladybirds (that felt the same but were different colours) in a tunnel and asked children, "which bug is in the tunnel – is it the red one or the blue one?" followed soon after by, "which one is it?"

Research investigating young children's understanding of language and communication had suggested that the phrasing of questions may influence children's performance (for a review of this literature see Siegal & Surian, 2004). For example, 6-year-olds do not always understand that an adult might refer to an item in several different ways, depending on how they want to emphasise its importance; indeed this misunderstanding may cause children to (incorrectly) change their initial response (Donaldson, 1978; Siegal, 1991). If this is the case, then tasks that refer to targets in several ways (such as Robinson & Whitcombe's study mentioned above) may be underestimating children's understanding. It also suggests that children may respond differently depending on the word that is used to refer to an item. Thus, young children's poor performance at aspectuality tasks may actually be a demonstration of their confusion due to the phrasing of the question. Other evidence does support this hypothesis. As mentioned in the introduction to this thesis, Pratt and Bryant (1988) demonstrated that 3-year-olds performed better on knowledge assessment tasks when the question they were asked was simplified.

Several authors in the aspectuality literature have suggested that children might find some of questions used in those tasks easier to deal with than others (O'Neill et al., 1992; Perner & Ruffman, 1995; Pillow, 1993). The identity question was used by O'Neill et al. (1992) and Perner and Ruffman (1995) to assess children's understanding of aspectuality. Both suspected that this type of question was particularly hard for children to deal with (though did not specify their reasons) and used the aspect question in following studies. Versions of the dimension question were used by Pillow (1993) (and also O'Neill et al. in parallel with the identity question). Again this type of question was thought to increase the difficulty of the task so the aspect question was adopted in later studies.

The aspect question has been suggested as easier for children to understand because it may remind children of the differentiating factor between the two original items (O'Neill et al., 1992). This could be because when the items are initially described to children during their pre-trial experience, they tend to be referred to by their perceptual aspect (e.g., it is pointed out that one is *red* and one is *blue*) (however, refer to the previous chapter for findings regarding the impact of verbal descriptions on children's performance). On the other hand, Pillow (1993) suggested that the aspect question may be easier to understand because it refers to a specific quality of an item (e.g., the fact that is red). This specific quality is distinct from the dimension of an item (e.g., colour) as that is more of an abstract concept and is more difficult for young children to understand. Nevertheless, during the pre-trial experience stage of aspectuality tasks the items are often referred to by their dimension too (e.g., it is pointed out that they are different *colours*).

It is possible that differences in difficulty of the test questions in aspectuality tasks may have masked children's understanding and their abilities may have been underestimated. Assessing children's performance with these questions would also reveal more about the robustness of their understanding of aspectuality. As mentioned in the introduction to this thesis, someone with a robust understanding would not be affected by such variations. It would not matter how an item was referred to. They would realise that no matter how the question was phrased, the same information was sought. Therefore, Experiment 7 aimed to carry out the first ever (known) direct comparison between the test questions that tend to be used in aspectuality tasks.

1. Experiment 7 – Does the phrasing of the test question affect young children's performance in aspectuality tasks?

To ensure that the only difference in the tasks was between the test questions, a discovery aspectuality task was used where two items were initially presented, then one item was hidden and had to be identified (see Experiment 1). The results of Experiment 2 showed that 4 to 5-year-olds can succeed at aspectuality tasks and perform well above what would be expected by chance. Therefore, in the current experiment this same age group were tested. Based on the evidence from the existing aspectuality literature it was expected that children asked the aspect questions would perform better than those asked either the dimension or identity questions. However, the literature makes no clear prediction as to whether these two latter questions would differ.

1.1 *Method*

Participants

Sixty children (30 girls) participated from three schools serving predominately working class populations in Leeds, U.K. Their ages ranged from 4;2 to 5;1 (mean 4 years and 8 months) and they were all reported by their teachers as possessing a good understanding of English. Ethnicity was distributed as follows: White (37), Black (10), Asian (10) and other (3).

Materials

The materials from Experiments 1, 3, 4, 5, and 6 were used.

Design

An aspectuality task was used where children were initially presented with two items that were the same in one perceptual modality and different in another. One was then hidden in a tunnel while the other was returned to a bag. Every child had four experimental trials: two required looking and two required feeling. Children were allocated to one of four orders of these trials as follows: (i) Look, Feel, Look, Feel (LFLF), (ii) FLFL, (iii) LFFL, (iv) FLLF. These orders were used to ensure that the first two trials did not require the same modality, which might encourage perseveration.

Procedure

Familiarisation. The familiarisation procedure was same as used in Experiments 1, 3, 4, 5, and 6.

Main trials. Children were allocated in turn to one of three test question conditions. Children given the aspect question were asked about the target ball with the relevant modality aspect mentioned (e.g., “find out if the one in the tunnel is the red one or the blue one”). Those given the dimension question were asked about the target ball with the relevant modality dimension mentioned (e.g., “find out what colour the one in the tunnel is”). Those given the identity question were asked about the identity of the target ball (e.g., “find out which one is in the tunnel”).

For the tactile targets the identity question used the same description ("which one") and the aspect question used the terms "hard or soft". However, as acknowledged by O'Neill et al., (1992), a true dimension question was difficult to generate for the tactile targets. It was not feasible to say "what the one in the tunnel feels like" because that would direct children to the correct action of feeling. It was also not possible to identify a child-appropriate label to describe the softness of the item that was equivalent to describing its colour. Therefore, in order to best replicate the existing research, the phrase used by O'Neill et al.'s (1992) was adopted. The dimension question for feeling trials therefore included the phrase "what the one in the tunnel is stuffed with."

At the beginning of each trial the children were presented with the two balls that were going to be used in that trial and asked to look at them and feel them properly. The results of Chapter 4 showed that pre-trial experience was not actually beneficial for young children's understanding of the task. However, in the present experiment children had to be familiar with the different ways of describing the items. This was because these descriptions were the basis for the different question phrasings, which was the focus of the study.

When the children were given the balls, therefore, the experimenter pointed out to the children how the balls were similar and how they differed, using references to their modality aspects and dimensions. This was to ensure that children were equally familiar with how the items could be described by their aspect and dimension. This was done while the experimenter described the perceptual attributes of each ball in turn, mentioning the differentiating modality first. For example, for a feeling trial, "this one is soft because it's stuffed with cotton wool and it's red and this one is hard because it's stuffed with a stone and it’s red. So these two balls are both the same colour aren’t they? They are both red so they look the same. But they feel different don’t they?” Or for a looking trial, “this one is red and it’s stuffed with cotton wool and this one is blue and it’s stuffed with cotton wool. So these two balls are both stuffed with cotton wool aren’t they? They’re both soft so they feel the same. But they look different don’t they?” The tactile dimension description (“stuffed with...”) was longer than the description used for the visual dimension, and took a different format. However, it was believed that if children had any particular difficulty with this label then it would become apparent in the analysis between the looking and feeling trials for the dimension question.

As a check that they understood the different visual and tactile descriptions the children were then asked to pass each ball to the experimenter. For example, for a pair of balls that differed in the tactile dimension they were asked to, “give me the hard one that’s stuffed with a stone” and “give me the soft one that’s stuffed with cotton wool”, and for balls that differed in the visual dimension they were asked to, “give me the one that is the colour red” and “give me the one that is the colour blue.”

The children were told that one of the balls would be hidden in the tunnel and the other one would be put back in the bag. This process took place underneath the cloth so that the children could not see which ball was placed where. The remainder of the procedure was as used in Experiments 5 and 6.

1.2 *Results*

Coding

All children passed the familiarisation check and so took part in the main experiment.

For the main trials children were given a score of 1 for each correct perceptual action chosen in each trial and 0 for every incorrect choice (see Table 7).

Table 7

Number of trials answered correctly in Experiment 7

Test Question Condition	Number of trials correct					Mean (Standard Deviation)
	0	1	2	3	4	
Aspect (*n*= 20)	0	1	5	6	8	3.05 (.95) ***
Dimension (*n*= 20)	0	3	8	5	4	2.50 (1.0) *ns*
Identity (*n*= 20)	1	8	8	2	1	1.70 (.92) *ns*
Expected frequencies if performance were at chance (n= 20)	*1.25*	*5*	*7.5*	*5*	*1.25*	*2*

Analyses

A repeated-measures ANOVA was conducted with test question condition (aspect and dimension and identity) as a between-subject factor and modality (looking trials and feeling trials) as a within-subject factor. A main effect of test question condition was found, $F(2, 57) = 10.07$, $p < .0001$, $\eta^2_p = .26$. Independent samples *t* tests (making a Bonferroni correction for 3 tests, $p <.0167$) showed that children who received the aspect question ($M = 3.05$, $SD = .95$) performed better that those who received the identity question ($M = 1.70$, $SD = .92$), $t(38) = 4.57$, $p < .001$, $r = .60$. Children who received the dimension question ($M = 2.50$, $SD = 1.0$) also performed better that those who received the identity question ($M = 1.70$, $SD = .92$), $t(38) = 2.63$, $p = .012$, $r = .39$. No difference was found between the aspect question ($M = 3.05$, $SD = .95$) and the dimension question ($M = 2.50$, $SD = 1.0$), $t(38) = 1.79$, $p = .082$, $r = .28$. There was no effect of modality and no interactions were found (highest $F = 2.82$, lowest $p = .10$).

Analysis was then carried out to see if children's performance improved over time. Paired-sample *t* tests showed no improvement in performance from the first two trials to the last two trials in any of the three conditions (lowest $p = .45$).

Finally, individuals' observed scores were compared to chance. Analysis showed that children performed better than would be expected by chance with the aspect question, χ^2 (4, $N = 20$) = 41.93, $p < .001$, but not the dimension question, χ^2 (4, $N = 20$) = 8.13, $p = .087$ or the identity question, χ^2 (4, $N = 20$) = 3.73, $p = .44$.

1.3 *Discussion*

The current experiment aimed to compare the different types of question used in tasks assessing young children's understanding of aspectuality and to establish any influence they might have on children's performance. It was hypothesised that if children had a robust understanding of aspectuality they would have no difficulty dealing with variations in the phrasing of the test question. However, the existing literature had suggested that children receiving the aspect question would perform better than those receiving the identity question and the dimension question. The results of Experiment 7 confirmed this. While children who received the aspect and dimension questions performed better than those who received the identity question, only those who received the aspect question performed better than would be expected by chance. First, the results will be discussed in relation to the suggestions made in the literature.

Referring to the aspect (e.g., red or soft) of an item in the test question was suggested as making it easier for children to understand (O'Neill et al., 1992; Perner & Ruffman, 1995). The current findings confirmed this. Children were most successful at the task when the specific quality of the item was mentioned in the test question. There is other evidence to suggest that children might find it easier to deal with the most explicit description of an item. For example, children seem to focus on the most obvious and salient feature of items when attempting to categorise them (Smith, Jones, & Landau, 1992). It is likely that if children most readily focus on the aspect of an item, then they will find this information the easiest to remember.

Asking children about the dimension of an item (e.g., its colour) was suggested as being equivalent to asking them about its identity (e.g., which one it was) (O'Neill et al., 1992). The current results showed that this was not so. Performance with the dimension question was not equivalent to performance with the identity question. Although performance with both question phrasings was no better than would be expected by chance, children who received the dimension question performed overall significantly better than those who received the identity question. Observation of the raw data suggested that this result might have been driven by children's performance on the dimension trials. Children who were asked to find out which colour item had been hidden (M = 1.45, SD = .61) found the task easier than those who were asked to find out "what the one in the tunnel is stuffed with" (M = 1.05, SD = .69). While children's performance with the identity question was poor for both the looking trials (M = .95, SD = .83) and the feeling trials (M = .75, SD = .79). If a functionally equivalent tactile question were found, children's performance on the dimension question could be even greater to that on the identity question. However, it remains to be seen whether this would improve children's performance with the dimension question to a level greater than chance.

It was also suggested that children would find the dimension question more difficult than the aspect question (O'Neill et al., 1992) due to the more abstract nature of the dimensional description (Pillow, 1993). The findings of the current experiment did not consistently support this hypothesis. Although performance on the dimension question was no better than chance it was not significantly different to performance on the aspect question. Again, it is possible that this was due to the difficulty of matching the phrasing of the tactile dimension question with the phrasing of the visual dimension question. Nevertheless the main analysis did not show a main effect of modality or an interaction between modality and question phrasing. Therefore it is clear that the tactile dimension question did not have a significant effect on children's performance. Future research may determine whether or not an equivalent tactile dimension (if found) would increase young children's performance on these trials. Until then it is difficult to fully assess the current findings with the dimension question trials, and compare them to the identity and aspect question results. Therefore, the focus in the remainder of this chapter and thesis will be on the findings regarding the aspect and identity question.

The main result of interest is that performance with the identity question was very poor with both visual and tactile trials. Children did not understand what perceptual action they need to take when they were asked to find out "which one" had been hidden. This was despite them, only moments earlier, dealing with the modality that differentiated the two items by handing those items back to the experimenter (and so focussing on the aspects of the items, for example, by passing back "the red one" and "the blue one" when requested). The difficulty children had with the identity question suggests that either they were not able to remember how the items differed, or they could remember but did not know what action to take. From the evidence shown here, it appears that children's difficulty is with recall.

To explain further, the current findings demonstrate that when they are given the identity phrasing, children *must* recall their experience of the items. This is because no clue is included in the question. For example, when children are asked to find out if the item is *red or blue*, or what *colour* it is, they can succeed at the task by making an association with looking. They do not need to remember how the items differed. In contrast, when asked to find out "which one" is hidden, they must remember the modality in which the items differed. There is no other way of them knowing how they differ. They must remember their pre-trial experience of the items. Children's poor performance in the identity task provided clear evidence that they had forgotten their pre-trial experience.

Young children's ability to recall their experience of the items has been shown to influence their performance on aspectuality tasks (Perner & Ruffman, 1995). These researchers found that children under the age of 6 years performed better when they were not given pre-trial experience of the items (see previous chapter of this thesis for further research on the influence of pre-trial experience). What is of interest here is that Perner and Ruffman (1995) used two types of aspectuality task to demonstrate the effect of experience, and an important secondary factor was also changed. As mentioned previously, their experiments either included, or did not include, pre-trial experience (the “two item test” and “one item test” respectively). However, changes were also made to the phrasing of the test question. Although Perner and Ruffman (1995) did not discuss these changes, they had to be made in order for children to understand how the items differed. For example, in their aspectuality task that included pre-trial experience (“two item task”) children were asked “which one” was hidden. It was intended that children would realise how the items differed during the pre-trial experience, so it was not necessary for this difference to be pointed out in the question. However, in their task that did not include pre-trial experience (“one item task”), children were asked if the hidden item was “black or white”. In this case children had not seen, felt, or been told about the items and so had no way of knowing how they differed. Therefore, the way in which the items differed *had* to be included in the test question. There is the possibility that these differences in the test question, and not the differences in the pre-trial experience, were responsible for their findings.

The findings of the present experiment offer some degree of clarification for this. They demonstrate that 4-year-old children perform at chance with the identity question (where they have to recall their pre-trial experience) but deal well with the aspect question (where they do not have to recall their pre-trial experience but can use the clues in the question to succeed). Therefore, children have more difficulty with the task when they *have* to recall their experience. These results offer support for Perner and Ruffman’s (1995) hypothesis that young children's ability to succeed on aspectuality tasks is related to the development of their episodic memory and their ability to recall their pre-trial experience of the items.

It is important to note that the current experiment differed from Perner and Ruffman's (1995) study. All children tested here were given pre-trial experience of the items, regardless of their test question, whereas the focus of Perner and Ruffman's (1995) manipulation was the presence, or not, of experience. Therefore, the results of Experiment 7 imply that while young children might have difficulty in recalling their pre-trial experience, they are not limited by their inability to remember the items. When they are given a useful clue in the question, and so do not have to recall the items, they perform well. This shows that children did realise when information included in the test question was relevant and useful.

In summary, the current findings suggest that 4-year-old children's understanding of aspectuality is robust to the extent that they realise when they can sometimes use evidence (from the test question). While they might fail to recall their experience of the items (as proposed by Perner & Ruffman, 1995) if there are sufficient clues in the test question, then children can successfully choose the correct perceptual access to gain information about the hidden item. However, their poor episodic memory does not allow them to recall how the items had differed, so if the test question does not offer any clues (e.g., "which one is in the tunnel") then children have difficulty knowing how the items differed and whether they need to look or feel.

These results have major implications for the aspectuality literature. Many use the identity question to assess young children's understanding without taking into account the difficulty that they have in recalling their pre-trial experience. For example, O'Neill et al. (1992) found that children under 5 years of age performed poorly when asked to find out *which* piggybank was hidden under a tunnel (despite having just felt that one was heavy and one was light). These children, who apparently fail aspectuality tasks, may understand the modality specific aspects of knowledge, but are unable to remember the items and are not given a specific target reference in the test question. It appears that future research investigating the development of aspectuality understanding may benefit from using an alternative procedure that allows for young children's poor recall ability.

CHAPTER 6 – GENERAL DISCUSSION AND CONCLUSION

The current research aimed to discover the limits of young children's understanding of sources of knowledge. More specifically, the intention was to find out whether, once gained, young children's understanding of aspectuality was robust. This was investigated by examining 4 to 7-year-old's ability to deal with changes and variations applied to standard aspectuality tasks. As someone with a robust understanding of aspectuality should have no difficulty dealing with such manipulations, it was intended that young children's performance on these tasks would reveal the extent of their comprehension.

Four manipulations were carried out over seven experiments. The first manipulation targeted the situational context of the task; the second aimed to discover whether children had difficulty dealing with irrelevant information included in the task; the third, whether the type of pre-trial experience they received affected their performance; and finally, if they were influenced by different target references. If children possessed a robust understanding of aspectuality, then their performance would not be disrupted by any of these manipulations. They would understand that specific perceptual knowledge could only be gained by particular perceptual actions, regardless of these variations.

Initially, the findings will be summarised and then each manipulation will be discussed in more depth. The robustness of young children's understanding of aspectuality will then be assessed in the light of the results reported here. Subsequently, the methodological and theoretical implications of this research will be considered, before this chapter and thesis are concluded.

1. Summary of Results

In all seven of the experiments in this thesis children took part in tasks assessing their understanding of perceptual aspectuality. These tasks followed a specific format inspired by methods that had been used by other researchers in the aspectuality field (e.g., O'Neill et al., 1992; Perner & Ruffman, 1995; Pillow, 1993). Children had to choose whether they needed to look or feel to gain specific visual or tactile information about a hidden item.

The current research showed that 4 to 5-year-olds could succeed at a basic task assessing understanding of aspectuality (Experiment 2). However, 4-year-olds encountered problems when the test question did not directly refer to the relevant aspect of the target (Experiment 7). Five and 6-year-olds were not affected by context alterations: They performed just as well when they had to identify a single hidden item, as when they had to locate a target item from two that were hidden (Experiment 1). Children had no difficulty dealing with irrelevant perceptual information about the target item that was included in the test question (Experiment 2 and 3). However, 5 to 6-year-olds did have trouble handling irrelevant, partially differentiating information that was included in the array of items (Experiment 4). In Experiment 5, the performance of 6-year-olds was worse when verbal descriptions of the perceptual qualities of the items were included in their pre-trial experience. Five-year-olds also performed poorly when given these verbal descriptions, even when the descriptions just consisted of the relevant differentiating perceptual information about the items (Experiment 6). Finally, a bias towards feeling was found in Experiment 2, but a bias towards looking was found in Experiment 3.

2. The Impact of Irrelevant Information

As proposed in the introduction to this thesis, someone with a robust understanding of aspectuality should be able to deal with irrelevant information. They should realise when irrelevant information can be ignored. For example, if they genuinely understand that looking will lead to knowledge of an item's colour, then they will realise that other perceptual information is irrelevant. Evidence suggests that 3-year-olds can show some understanding of when information is relevant or irrelevant in visual search tasks (e.g., Sophian & Wellman, 1980). However, children's ability to deal with irrelevant information in aspectuality tasks had never been investigated. The aim here was to find out if young children could ignore irrelevant information in these tasks as this would be one way of demonstrating the robustness of their understanding of sources of knowledge.

The results of the current research showed that young children were sometimes able to deal with irrelevant information that was included in their task. Their success depended on how and when the irrelevant information was presented to them. In Experiments 2 and 3, all the age groups tested (4, 5, and 6-year-olds) coped well with the inclusion of irrelevant information in the test question. For example, they were able to correctly choose to look to find the "red soft one" when the two items hidden were both soft and differed only in colour. In Experiments 3 and 4, however, children showed more difficulty handling irrelevant information that was included in their pre-trial experience. The 5 and 6-year olds tested here had problems choosing the correct perceptual action to find the target when partially differentiating (PD) information was included in the array. For example, they had difficulty choosing to feel to find "the soft one" when the four objects all felt different but two were red and two were blue. To recap, irrelevant information in the pre-trial experience caused children difficulty but irrelevant information in the test question did not.

How can the different effects of irrelevant information be explained? They can, by considering the four stages of the aspectuality task. At the beginning of each trial the children had experience of the items; then the target item was hidden; after that the test question was asked; and finally children made their choice of perceptual action. The results of Experiments 2, 3, and 4 showed that children were affected by irrelevant information in the first stage, but not irrelevant information in the penultimate stage. Consequently, Perner and Ruffman's (1995) theory is supported: It is the pre-trial experience stage that is important for children's understanding. The findings of Experiments 2, 3, and 4 demonstrate that it is the pre-trial experience stage where children's comprehension can be more easily disrupted. It is possible that the knowledge gained in pre-trial experience is the most vulnerable and the least robust.

The importance of pre-trial experience will be addressed again in subsequent sections of this discussion. For now, future research concerning irrelevant information will be considered. The impact of irrelevant information produced interesting and apparently conflicting results. It is possible that other stages of the aspectuality task are susceptible to the influence of irrelevant information and this could easily be tested. For example, the final stage of the task (when children choose the perceptual access they want to take) could be adapted to include irrelevant information. Children could be offered an additional perceptual access option. For example, they could be asked if they wanted to look or feel or *listen* to find out the colour of the hidden item. If they had only looked at or felt the items during their pre-trial experience stage, it is likely that they would realise that listening was irrelevant (according to the present findings). If, however, they behaved as though listening would give them knowledge about the hidden items visual or tactile qualities, this could have important consequences for the aspectuality literature. It might exemplify children's confusion over the modality specific aspects of knowledge, or demonstrate their inability to recall the relevant action performed during their pre-trial experience.

In summary, irrelevant information only influenced children's performance when it was included in the first stage of the aspectuality task. It had no effect when it was included in the penultimate stage. This demonstrated that children's understanding of the task was dependent on the information in their pre-trial experience rather than the information in their test question. The next section will build on this discussion by considering other apparently contradicting evidence that shows children's performance affected by information in their test question.

3. Target References

In the previous section of this discussion it was shown that the pre-trial experience of the items was important for children's understanding, rather than the information that was in the test question. The changes that were made to pre-trial experience resulted in disruptions to young children's performance, whereas additional information included in the test question had no effect (Experiments 2, 3, and 4). Nevertheless, the results from Experiment 7 suggest otherwise. In Experiment 7, the aim was to find out if children's performance was influenced by the different phrasings of the test question that had been used in some of the aspectuality literature (e.g., O'Neill et al., 1992; Pillow, 1993; Robinson et al., 1997).

If children's performance depended on their pre-trial experience (as shown in the previous section) they should have performed well in Experiment 7, regardless of the way the test question was phrased. However, this was not what was found: Children's performance differed according to the way the target was referred to in the test question. Children had little difficulty when their test question referred to a specific aspect of the target, for example, if it was red or soft. However, when they were asked to determine which item had been hidden, and the quality of that item was not directly referred to, their performance was at chance level. Whereas in Experiments 2, 3, and 4 children seemed to be focussed on their pre-trial experience rather than the information in their test question, in Experiment 7 the reverse appeared to be true.

How can this apparent conflict be explained? One possibility concerns the way in which the target was referred to. In Experiment 7 children had difficulty when the test question did not directly refer to an aspect of the target, and they were asked to find out, "which one" had been hidden. In Experiments 2, 3 and 4, the test question always referred to either one or both of the target's perceptual aspects. For example, the simple question might refer to it as being "the red one", whereas the complex question might refer to it as being "the red soft one". In Experiment 7 it was also found that children performed well at the task when their test question referred to the target, for example, when they were asked to find out if it was "the red one or the blue one" that was hidden. In other words, when the perceptual aspects of the target were mentioned in the test question children performed well, but when the target was not directly referred to in this way they performed poorly. The way that the items were described in the question appeared to have had a major effect on young children's performance.

There is other evidence to suggest that young children are sensitive to the way items are described. They can have problems making associations between items and the labels that refer to them. For example, Apperly and Robinson (1998, 2002) propose that 4 and 5-year-old children have difficulty fully understanding the relationship between an item and its representation: they do not understand that an item can be correctly referred to in many different ways. Although this example denotes labels rather than types of reference, it could also explain children's performance in Experiment 7. Here the target was referred to directly (e.g., by aspect or dimension) and indirectly (e.g., by being the "one" that was hidden). Children found it easy to deal with direct references (e.g., red or colour) but difficult to deal with indirect references (e.g., "which one"). It seems that young children can understand the relationship between an item and its reference better when that reference is direct.

Nevertheless, there is an alternative possibility. The findings from the previous section of this discussion clearly showed that it was the pre-trial experience that was important for children's understanding of the task, not the test question. Perner and Ruffman (1995) also suggest that children's experience is crucial in aspectuality tasks. So can the results of Experiment 7 be explained with relation to pre-trial experience? The answer lies in the connection between children's pre-trial experience and the phrasing of the identity question. When children were asked to identify "which one" was hidden, they were forced to think back to their pre-trial experience of the items because no perceptual information was included in the test question. As there was no perceptual information in the test question that could direct them towards the correct perceptual action to take, they had to remember how they had found out the difference between the two items (by either looking or feeling). In contrast, when children received the aspect or dimension question they were given perceptual information about the target in the test question. For example, they were asked to find out whether it was red or blue and this information could direct them towards the correct action of looking. This is particularly important because aspectuality tasks often ask children to find out "which one" was hidden, without necessarily considering their recall ability (e.g., O'Neill et al., 1992; Robinson et al., 1997). It could be that children's ability to succeed at aspectuality tasks has been underestimated because of the way the target is referred to in the test question.

Another possibility concerns the age of the children tested. In Experiment 7 the 4-year-old participants showed little ability to recall their pre-trial experience. Even though they were asked to hand back the items to the experimenter they still did not remember how the items differed. For example, children were asked to hand back "the red one" and "the blue one" which required them to differentiate them by looking, but moments later when they were asked to find out "which one" was hidden, they had difficulty. However, the children that were given the complex test question in Experiments 2 and 3 did seem to have some recall ability. These children (youngest were 4 to 5-year-olds) must have been able to remember the items as their test question did not give them any clue as to which perceptual action they should choose.

To recap, the current research showed that when the target was not directly referred to in the test question and children were forced to recall their pre-trial experience of the items, they had difficulty with the task. However, when the target was directly referred to in test question, children had no need to recall their pre-trial experience and performed well. This means that the 4-year-old's performance in Experiment 7 was dependent on their ability to recall their pre-trial experience. This supports Perner and Ruffman's (1995) theory that young children's poor episodic memory affects their performance on aspectuality tasks: If children have difficulty recalling their experience then they have problems understanding which perceptual action they need to take.

How does this explain children's ability to deal with the complex test question in Experiments 2 and 3? Here the target was referred to, but both its perceptual qualities were mentioned. In this case, children could not have been directed towards the correct mode of perceptual access by the information included in the test question. Children must have been able to recall their pre-trial experience to succeed at the task. Nonetheless, it is possible that these children did have difficulty recalling the items, but being told the target's perceptual qualities in the test question prompted their memory. Even though both aspects of the target were mentioned and this was not enough to direct them towards the correct perceptual access, it was enough to remind them of their pre-trial experience and the items that they saw and felt. There is other evidence to suggest that verbal cues can increase young children's recall ability, even when the prompts are non-specific (e.g., Elischberger & Roebers, 2001). However, further research is needed to confirm this effect with relation to understanding sources of knowledge. Whether young children's recall of their pre-trial experience can be prompted by the references in the test question or is evidence of a more developed episodic memory, should be the subject of future research.

In particular, these future studies could clarify young children's ability to recall perceptual information when prompted. Children could be asked to recall how two items differed, following; no prompt; a non-specific prompt (e.g., "think about the balls"); a relevant prompt (e.g., "think about the red one"); an irrelevant but somewhat useful prompt (e.g., “think about the red soft one”); and an irrelevant and un-useful prompt (e.g., “think about who they belong to”). If children were able to make use of information to increase their recall ability this could have important implications for how items are referred to in future aspectuality tasks. It could be that aspectuality test questions will no longer include direct target references, as they have been shown to assist children in their choice of perceptual action. On the other hand, the findings from the current and future research may do no more than standardise the way that targets are described in these tasks.

So far in this discussion, it has been shown that children have difficulty recalling their pre-trial experience (Experiments 3, 4, & 7) but suggested that their ability to remember this event is responsive to prompts (Experiments 2 and 3). The next section will focus in more detail on the influence of pre-trial experience and its implications regarding the robustness of young children’s understanding of aspectuality.

4. The Impact of Experience

The results discussed up to now have demonstrated that young children focus on what they experience during the pre-trial procedure in aspectuality tasks. As previously stated, Perner and Ruffman (1995) also proposed that this part of the procedure plays a crucial part in young children’s understanding. They showed that children performed better in aspectuality tasks when they did not receive any pre-trial experience of the items. In Experiments 5 and 6 this was tested. These experiments also aimed to discover whether children found some types of pre-trial experience more difficult to deal with than others. If children were susceptible to different types of pre-trial experience then this would reveal more about the robustness of their understanding.

Why do Perner and Ruffman (1995) believe that pre-trial experience is so important? They suggest that to succeed at an aspectuality task children have to remember "which sense modality they used in the warm-up phase" (p. 539). In other words, children have to recall their pre-trial experience with relation to the perceptual action that allowed them to differentiate between the items (e.g., remembering looking). This is opposed to recalling how the items themselves differed (e.g., remembering that one was red and one was blue). Therefore, it is the information that children gain from their own perceptual action that is crucial to their understanding, rather than information gained in any other way. Perner and Ruffman's (1995) hypothesis can be interpreted to suggest that when young children have difficulty recalling their pre-trial experience, they are in effect failing to recall their self-directed access. In other words, if children cannot remember what action they took to find out knowledge, then they do not understand what action they need to take to gain further information.

In Experiment 5, therefore, the presence and absence of children's self-directed experience should have been the focal point of the findings. If children had received self-directed experience then they should have performed well. If they had not received it, they should have performed poorly. However, the results showed that self-directed experience was no better or worse than any other type of experience and, more importantly, it was no better or worse than receiving no experience at all. Children's ability to recall their self-directed pre-trial experience did not seem to affect their success at the task. Quite the contrary was found: The presence and absence of verbally-directed information in children's pre-trial experience was the focal point of these findings.

Subsequently, the current research agrees with Perner and Ruffman (1995) only in so far as young children's success with aspectuality tasks is based on their ability to deal with their pre-trial experience. However, while Perner and Ruffman suggest that children have difficulty recalling their self-directed experience, the results of Experiment 5 and 6 demonstrate that young children have difficulty in recalling information that is told to them during their pre-trial experience. It is this difficulty with verbal information that disrupts children ability to succeed at aspectuality tasks. Children's problem recalling the experimenter's descriptions of the items means that they find it harder to choose what perceptual action they need to take.

Why might young children have particular difficulty in recalling verbal information and why does this affect their understanding of the aspectuality task? One possibility concerns the determining features of episodic memory. As mentioned in the introduction, episodic memory specifically allows one to recall something as having been personally experienced, as opposed to knowing something but not recalling how one has come to know it (e.g., Perner, Kloo, & Gornik, 2007; Tulving, 1985). Additionally, episodic remembering is distinctive in that it requires both recalling an event and introspecting about it (Perner, Kloo, & Stottinger, 2007). In other words, to be able to recall an event, one must be able to introspect on *what* was found out during that event and *how* it was found out.

So what does this mean as far as aspectuality tasks are concerned? It means that young children must personally experience the items in aspectuality tasks in order to be able to introspect about their knowledge and understand what action they need to take (Perner, Kloo, & Gornik, 2007; Perner, Kloo, & Stottinger, 2007; Perner & Ruffman, 1995). They must carry out the actions of looking and feeling in order to succeed at the task. If, as in Experiments 5 and 6, they have only had verbal experience of the items, then they cannot introspect about looking and feeling, as they did not perform those actions. This could be why children who just received verbal experience performed less well. Being told perceptual information does not allow introspection in the same way that looking and feeling does.

How does this explanation account for those children who received the combined experience? These children were given the verbal descriptions but also carried out the looking and feeling actions. They should have been able to introspect on their pre-trial experience and re-enact the perceptual access that had given them knowledge of the items. Based on Perner, Kloo, and Gornik's (2007), Perner, Kloo, and Stottinger's (2007), and Perner and Ruffman's (1995) suggestion, one would have expected these children to perform well. Also, as previously mentioned, combining relevant prior information has been shown to improve 5 and 6-year-old children's recall of an event (McGuigan & Salmon, 2005). Yet in Experiment 5 the opposite effect was found. The addition of the verbal descriptions appeared to lessen any advantage that children might have gained from their self-directed experience.

These findings from Experiments 5 are particularly important because most aspectuality and sources of knowledge tasks in the existing literature have involved children receiving such combined pre-trial experiences. Children tend to be given the items to look at and feel, while the experimenter describes them (e.g., O'Neill et al., 1992). One possible explanation for children's poor performance in the combined pre-trial experience condition concerns the additional cognitive effort required. Young children do show signs of difficulty when trying using two simultaneous strategies to solve a problem (e.g., Goldin-Meadow, Nusbaum, Garber, & Church, 1993). It could be that it is extremely effortful for young children to hold in mind both verbal information and self-directed information while reasoning about what action they need to take to find a target. Therefore, when they are attempting to recall verbal descriptions, their ability to recall their self-directed introspections is reduced, along with their ability to decide which perceptual action they need to take to succeed at the task. This possibility could be investigated further by directly comparing children's ability to recall perceptual information accessed in different ways (e.g., verbally and self-directed) and testing how much cognitive effort is used for each method (e.g., by assessing their performance on a secondary task run simultaneously).

The findings from Experiment 5, however, showed that children performed poorly when they received combined experience *and* just verbal experience. Also, in Experiment 6 the detrimental effect of verbal experience seemed to be maintained even when the amount of verbal information was reduced. There is other evidence to suggest that children find event information harder to recall when they had heard about it, than when they saw it, or had taken part in it (e.g., Gobbo et al., 2002). However, the idea that the presence of *any amount* of verbal information can reduce the effect of other sources of knowledge requires further investigation. One possibility is that children have difficulty dealing with particular verbal labels and referents (and this could explain the effect found with the tactile dimension question in Experiment 7). Therefore, if children were given the opportunity to create their own descriptions for the items they might show greater recall of this verbal information. It could be that the more salient the description is, the easier it is for children to remember.

In summary, it had been suggested previously, in this discussion and by Perner and Ruffman (1995) that young children depend on recalling their pre-trial experience to succeed at tasks assessing understanding of aspectuality. On the basis of Experiments 5 and 6 it is now argued that young children's difficulty is with recalling the verbal information included in their pre-trial experience and that this difficulty disrupts their ability to succeed at the task. The next section will discuss the final set of findings from the current research concerning modality biases.

5. Modality Biases

Evidence suggests that young children are initially biased towards the visual modality: At around 3 years of age young children behave as if looking will give them all the information they need about to know about the perceptual qualities of an object (e.g., Pillow, 1989; Pratt & Bryant, 1990; Wimmer, Hogrefe, & Perner, 1988). For example, they act as though they can find out whether a toy contains a rattle or a bell just by looking at the uninformative shape of the toy (Pillow, 1993).

The aspectuality literature is unclear about why older children can still show modality biases. Some studies have shown that up until 6 years of age, children tend to prefer looking as a source of knowledge: they believe that visual access will inform them about tactile qualities (e.g., Perner & Ruffman, 1995). However, preferences for feeling have also been shown (Naito, 2003; O'Neill et al., 1992). The general consensus seems to be that young children sometimes do show biases towards particular perceptual modalities, even after 3 years of age, when they are thought to have a better understanding of the modality specific aspects of knowledge. Nevertheless, the importance of these biases in the development of aspectuality understanding has never been directly addressed, and the current research aimed to correct this.

The findings from the research carried out here gave a mixed picture of young children's bias towards perceptual modalities; analyses showed modality bias in two of the seven experiments. The 4 to 5-year-olds tested in Experiment 2 showed a preference for feeling, yet the 5 and 6-year-olds from Experiment 3 were biased towards looking. The results of Experiment 2 demonstrated that 7 out of the thirty children tested always chose to feel. It is suggested that the equipment used influenced this feeling preference: it was only in this experiment that bags were used and only in this experiment that this tactile bias was found. Putting a hand into a bag to take something out is a very common occurrence. Children may well have been accustomed to taking an object out of a bag with their hand, so that it could be looked at and played with. Feeling an object while it is still inside a bag, however, is an unusual act. This is particularly so when the hand is not inserted into the bag, but feels the object from the outside of the bag, as was done in this experiment. It is possible that this distinct and unusual action attracted children's attention and meant that they always choose to feel. In other words, although they could have been expected to prefer to carry out more familiar acts, in this case children may have chosen to feel because they liked carrying out that atypical action.

If using the bags to hide the items encouraged the children to feel, did using the tunnels encourage them to look? Tunnels have been used in much of the aspectuality literature (e.g., Perner & Ruffman, 1995; O'Neill et al., 1992; Robinson & Whitcombe, 2003) and, although biases have often been found, they were not always in favour of looking. For example, as stated previously, O'Neill et al. (1992) found preferences for both looking and feeling in their series of experiments using the same tunnel apparatus. This would imply that modality biases occur by chance or for other undisclosed reasons. The current findings support this suggestion and can be demonstrated in two ways. First, the tunnels were used in all the experiments except Experiment 2, yet it was only in Experiment 3 that a looking bias was found. Further analysis indicated that this was driven by children's difficulty dealing with PD in the array of items: an interaction showed that children had particular difficulty with PD information in their feeling trials. Second, there was an indication of a preference towards looking in Experiment 7 with children who were given the dimension question. Children had particular difficulty dealing with the unusual sentence construction for the tactile dimension question. Therefore, it is possible that additional complexities such as PD information and unusual sentence construction can contribute towards modality preferences.

Consequently, the effect of equipment in influencing modality bias is not important. What is important is the actual behaviour of the children who showed these biases. Two factors must be considered: how children's behaviour was analysed and whether they were confident in their judgements or merely guessing. Regarding the first point, for analysis to show a modality bias, a significant number of children must have chosen one form of access on almost every trial, if not every trial. They would have always (or almost always) chosen to look, or always (or almost always) chosen to feel. This would have resulted in them being correct on approximately half their trials, albeit accidentally. In the other experiments, where the bias was not shown, some children may have chosen the wrong perceptual access on most, or all their trials, but not mainly chosen either to look or to feel. Where care must be taken, is in interpreting low, or chance performance as being different to biased performance. In all cases it should be apparent that the children did not understand aspectuality: they did not comprehend the link between the correct source of knowledge and subsequent information. Comparing individual children's performance to what would be expected by chance (as was done in this thesis), rather than merely evaluating their mean scores, allows a more accurate assessment of whether children were biased or merely guessing.

The second point is regarding the confidence of children's judgements. The children who showed bias in the current experiments did not appear to be randomly choosing just one form of perceptual access. Many of them acted as though they genuinely believed they could find out the information they needed from just one perceptual action. For example, they seemed confident that they could tell the colour of the balls just by feeling them from outside the bag: one child distinctly said, "This one definitely feels red". Most children did not behave as though they simply preferred performing that action without considering the outcome.

Colour can sometimes be inferred without direct visual contact, however, (Robinson et al., 1997), and young children do show some ability to use inference as a source of knowledge, even if they cannot explain how they have inferred it (e.g., Pillow & Anderson, 2006; Sodian & Wimmer, 1987; Varouxaki, Freeman, Peters, & Lewis, 1999). However, the experiments in this thesis did not afford success with such actions. There was no way that children could infer the colour or tactile qualities of the hidden items without looking or feeling. Thus, children who showed biased behaviour clearly did not understand perceptual aspectuality any more than children who guessed on every trial.

Nonetheless, it would be interesting to investigate further young children's confidence in their biased behaviour. It would enhance the existing literature if we could find out why some 5-year-olds, who should understand the modality specific aspects of knowledge, act as though one modality will give them all the perceptual information they require. Evidence suggests that is possible to ask children of this age, and even younger, to say why they hold certain beliefs. For example, children over 3 years of age are able to justify how they have gained knowledge and suggest how knowledge can be acquired (e.g., O'Neill et al., 1992; Wimmer, Hogrefe, & Perner, 1988; Wimmer, Hogrefe, & Sodian, 1988). Therefore, future research could ask children to explain how they believe they can tell an item's colour by feeling, if they say they can. Or, on the other hand, they could be asked to rate their certainty of an object's colour when they have been feeling it (e.g., they are guessing) and when they have been looking at it (e.g., they know).

In conclusion, biases towards particular forms of modality access are apparent in aspectuality tasks after children reach 3 years of age. Children who show these biases behave as though one mode of access will give them multiple types of perceptual information. It is possible that these biases are a demonstration of the difficulties young children sometimes have with the aspectuality task, and how their preferences may be directed by particular equipment used. It could be that when children have to deal with a situation that they are unsure about, they revert back to a previously used strategy. In this case the strategy that one form of perceptual access will lead to all types of perceptual knowledge. How do the current results add to the aspectuality literature? Modality biases demonstrate only that aspectuality is not robustly understood, and consequently, as long as children's performance is analysed correctly, little regard should be paid to which particular modality is preferred.

The next section of this discussion will pull together all the findings from the current research. This is in order to determine whether young children's understanding of aspectuality is robust, or whether their ability to succeed at the tasks are subject to performance related issues.

6. Is Young Children's Understanding of Aspectuality Robust?

The research discussed here has shown that young children attempted to recall the information they gained through pre-trial experience in order to succeed at the tasks. However, they had difficulty recalling this experience. Specifically, they found it harder to recall verbal information than knowledge that they had gained through self-experience. However, remembering the pre-trial experience is only really necessary if children are asked a non-referencing "which one" question. If children are asked if it is "the red one" that is hidden then they do not *have* to re-experience their initial contact with the balls. In this case the information in the question directs them towards the appropriate answer. Children could just associate the correct sense modality (e.g., looking) with finding the perceptual information mentioned (e.g., red).

The current research has demonstrated that children do not always use this perceptual information in the test question to help them succeed at the task. The results from Experiment 7 indicated that 4-year-olds relied on this information, but only because they had real difficulty recalling their pre-trial experience. In this study it was particularly clear that children could not recall their pre-trial experience. They were unable to remember what actions they had just used when they had handed the items back to the experimenter.

In Experiments 2 and 3 it was also shown that children could use the perceptual information in the test question, but this time it appeared to be as a prompt to recall their pre-trial experience. However, in Experiments 4, 5, and 6 (and other experiments when the simple test question was used) a different pattern of behaviour became apparent. Despite the enormous hint in the question (e.g., "find the red one") the children tested here still attempted to recall information from their pre-trial experience to succeed at the task. Even when they struggled with recalling the PD information in Experiment 4 they did not realise that they could succeed at the task by attending to the information in the test question. Even when they had difficulty recalling the verbal information in Experiments 5 and 6, they did not realise that they could succeed at the task by just associating the quality mentioned in the test question with the appropriate action.

So it seems that children cannot reliably make use of the perceptual information they are told in the test question. They do not always recognise when this verbal information can help them. They also have difficulty recalling verbal information from their pre-trial experience. Consequently, the problem that these children have with aspectuality tasks is not only with remembering verbal information (as proposed previously). The trouble that these children have with aspectuality tasks is also in knowing when verbal information is useful to them and when it is unimportant. In summary, they have difficulty both recalling verbal information and recognising the usefulness of verbal information.

What must be considered now is how this problem with verbal information relates to young children's understanding of aspectuality. Does it demonstrate a lack of robustness in their understanding? Or is it a separate difficulty that causes them to perform poorly on these tasks? As mentioned previously, there is evidence that children under the age of 8 years can have difficulty rehearsing articulatory information (e.g., Kemps et al., 2000). This would include information they have been told and are trying to remember. Also, young children can have more difficulty recalling verbal information than other types of information (e.g., Gobbo et al., 2002; Murachver et al., 1996) although this is not always the case (e.g., McGuigan & Salmon, 2005). There is also research showing that young children do not treat verbal information as a valid source of knowledge, for example, by attributing ignorance to someone who had been told of an item's identity (Pillow, 1989; Pratt & Bryant, 1990; Wimmer, Hogrefe & Perner, 1988; Woolley & Wellman, 1993).

The examples just described demonstrate that young children can have trouble recalling verbal information and recognising its importance. Therefore, these difficulties are not specific to tasks assessing understanding of aspectuality. They are apparent when other cognitive processes are being tested. Consequently, young children's difficulties with verbal information are not a demonstration of how aspectuality is misunderstood. They do not reveal the lack of robustness of young children's understanding of aspectuality. Rather, they are performance problems that become apparent while children's understanding of aspectuality is being tested.

The next section will discuss how the findings generated by the current research relate to the existing aspectuality literature. The way that future research might tackle these issues will also be addressed.

7. Methodological and Theoretical Implications

Aspectuality understanding requires comprehension of the modality specific aspects of knowledge (e.g., O'Neill et al., 1992; Perner, 1991). For example, understanding that if you want to find out the colour of something then you will need to look, and realising that other forms of perceptual access will not give you the information that you need. From this it would appear that demonstrating an understanding of aspectuality involves recognition of the modality specific aspects of knowledge and the ability to make active use of this knowledge. Knowing *how* to discover particular perceptual information would be the important skill here. The current research has focussed on children's ability to find out specific perceptual information, for example, whether an item is red or blue.

In some of the aspectuality tasks that have featured in the literature, however, young children are not only required to find out particular perceptual information. They are also required to recall information. For example, they are asked "which" of two items is hidden and must remember how they discovered the difference between them (e.g., O'Neill et al., 1992; Robinson et al., 1997). However, it is argued here that if you genuinely understand what perceptual action is needed to find out specific perceptual information, then your ability to remember a particular experience is irrelevant. If you understand how to gain knowledge then why should your ability to recall information even be considered?

Understanding aspectuality does not have to include recall. If understanding aspectuality just means knowing what perceptual action leads to specific perceptual information, then children do not need to have pre-trial experience of the items. If they know what action they need to take to find out particular information then that is enough.

Their poor abilities in dealing with and recalling verbal information should not become an issue. If, on the other hand, understanding aspectuality means more than this, then recall might be important. If understanding aspectuality means being able to figure out how items differ perceptually and then what perceptual action is needed to identify which one is hidden, then children do need to be able to recall their pre-trial experience.

A further consideration must be how adults would respond to aspectuality tasks and whether they would show the same tendencies as young children. Considering the functioning of a mature understanding of aspectuality could reveal more about its development. For example, if adults were to show any difficulties with aspectuality tasks, would those difficulties be in recognising the relevance of verbal information? Or would different processes be involved? Future research could answer these questions by comparing children's and adult's performance on functionally similar aspectuality tasks.

So, what must be established now is how a genuine understanding of aspectuality should be assessed: whether it requires knowing how to find out perceptual information, or whether it requires being able to figure out, remember, and then find out perceptual information. As suggested in the introduction to this thesis, the main difference between children's and adult's use of sources of knowledge is that adults tend to make their judgements spontaneously, without explicit reflection (e.g., Flavell, 2000). Also, aspectuality tasks that have allowed children to repeat perceptual actions that they have previously carried out have been criticised (e.g., Robinson, Haigh, & Pendle, 2008). This is because children could succeed at these tasks by replicating behaviour, rather than really understanding the importance of specific perceptual access as evidence for knowledge states. If children need to recall their self-directed pre-trial experience to succeed at an aspectuality task (Perner & Ruffman, 1995) then they could be just replicating their behaviour and not understanding aspectuality.

It seems that in the future aspectuality understanding should be assessed spontaneously, without the need for reflection. The emphasis should be on asking young children to find out perceptual information, rather than asking them to recall it. Only then can their genuine understanding of the modality specific aspects of knowledge be evaluated.

8. Relation to ToM and Other Cognitive Processes

In the introduction to this thesis the link between understanding sources of knowledge and understanding other cognitive processes was reviewed. It was suggested that comprehension of aspectuality and possession of a ToM relied on the recognition of the importance of sources of knowledge. To succeed at aspectuality tasks children have to understand what perceptual action will give them the knowledge they need. To succeed at ToM tasks children have to understand how someone's belief is based on the evidence from knowledge gained. The two abilities are therefore intricately connected. They demonstrate that understanding how to gain knowledge is associated with understanding how knowledge has been gained. While the current research focussed on young children's understanding of how to gain knowledge, both abilities rely on a comprehension of the importance of evidence in forming beliefs.

Evidence is not only important for understanding aspectuality and ToM. It is also important for scientific thinking (Pillow et al., 2000), evaluation of truth (Robinson et al., 1999; Robinson, Haigh, & Nurmsoo, 2008), and social interaction (Gopnik & Astington, 1988; Hogrefe, Wimmer, & Perner, 1986; Perner, Leekham, & Wimmer, 1987; Wimmer & Perner, 1983). Therefore, the present findings have wider implications than just understanding of aspectuality. Young children's difficulty in recalling and recognising the importance of verbal information could influence their performance in all these areas. It is possible that young children's understanding has been underestimated because of their problems in dealing with verbal information. Future research should allow for such difficulties when assessing children's abilities.

Experimental designs that allow for performance difficulties can reveal more about young children's implicit understanding. For example, assessing non-verbal or preferential looking responses showed that children younger than expected can understand another person's false belief (Clements & Perner, 1994; Garnham & Ruffman, 2001; Onishi & Baillargeon, 2005). Even these infants and pre-school children appeared to understand the role of evidence in understanding beliefs. It is possible that using less demanding methods (e.g., requiring no verbal information or recall) when assessing understanding of other knowledge states would result in younger children than expected succeeding at these tasks.

The results of the research carried out for this thesis demonstrate young children's difficulty in understanding and remembering verbal information. It was mentioned earlier how young children had specific difficulty dealing with indirect references to items (Apperly & Robinson, 1998, 2002). It was also shown how children did not always seem to recognise the relevance of verbal information (Experiments 4, 5, & 6). It is possible that young children treat being told information as an indirect knowledge source whereas looking and feeling are treated as direct. In other words, children behave as though hearing information is like making an inference; both sources are indirect and both require additional cognitive effort. It has been shown that children do not successfully recognise inference as a valid source of knowledge until they are at least 8 years of age (Pillow et al., 2000). It is possible that recognising verbal information as a valid source of knowledge is a similarly later development in young children's understanding of knowledge sources.

In summary, the results of the current research not only have implications for how aspectuality is tested in the future. They should also be considered when children's understanding of other knowledge states and beliefs are being assessed. It is possible that young children's performance on other tasks is influenced by their difficulty in recalling and recognising the usefulness of verbal information.

9. Conclusion

The aim of this thesis was to discover the limitations of young children's understanding of sources of knowledge. The existing literature had suggested the age at which children could succeed at aspectuality tasks (e.g., O'Neill et al., 1992; Perner, 1991) but had not considered whether, once apparent, this understanding was robust. The findings from the current research have enhanced the extant research in several ways. It is now apparent that young children's understanding of aspectuality is robust across contextual situations; they are just as able to discover information about a single hidden item as locate an item amongst many that are hidden. It has also been shown that 4-year-olds can perform well at basic aspectuality tasks, younger than previously thought. Nevertheless, if an aspectuality task requires a 4-year-old to find out "which one" is hidden, then they perform badly. This result, among others reported in this thesis, demonstrates that children's success at aspectuality tasks is associated with their ability to recall their pre-trial experience, supporting Perner and Ruffman's (1995) hypothesis. However, the current research has added to Perner and Ruffman's (1995) theory by establishing that it is not the experience as a whole that is the cause of the problem. Rather, young children have specific difficulty in recalling verbal information. They also encounter problems in realising when verbal information can be useful to them, for example, when the target is specifically referred to in the test question.

In conclusion, young children have difficulty in recalling verbal information and recognising when verbal information is useful to them. These specific impediments prevent children succeeding at tasks assessing aspectuality. The difficulties they have in dealing with verbal information limit their ability to demonstrate their understanding of sources of knowledge. Consequently, even at the age of 6 years, their comprehension of aspectuality should not be described as robust but rather as vulnerable to certain performance restrictions. As a result, future research should consider assessing children's active understanding of aspectuality, rather than relying on methods that require reflection.

APPENDIX

CROSS TABULATIONS FOR LOOKING AND FEELING RESPONSES

Experiment 1 discovery task (5-year-olds)

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	1	1	0	2
	1	3	6	10	19
	2	1	2	12	15
Total		5	9	22	36

Experiment 1 discovery task (6-year-olds)

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	2	1	3
	1	0	1	7	8
	2	0	3	22	25
Total		0	6	30	36

Experiment 1 location task (5-year-olds)

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	1	2	0	3
	1	2	8	8	18
	2	3	3	9	15
	Total	6	13	17	36

Experiment 1 location task (6-year-olds)

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	1	2	2	5
	1	0	4	5	9
	2	0	4	18	22
	Total	1	10	25	36

Experiment 2 simple question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	2	2	4
	1	0	5	1	6
	2	0	1	5	6
Total		0	8	8	16

Experiment 2 complex question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	0	5	5
	1	1	2	0	3
	2	0	2	4	6
Total		1	4	9	14

Experiment 3 FD simple question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	1	3	4
	1	3	10	5	18
	2	3	9	12	24
	Total	6	20	20	46

Experiment 3 PD simple question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	1	1	2
	1	3	12	2	17
	2	8	12	7	27
	Total	11	25	10	46

Experiment 3 FD complex question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	1	4	1	6
	1	1	14	4	19
	2	2	6	13	21
Total		4	24	18	46

Experiment 3 PD complex question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	2	1	5	8
	1	3	10	3	16
	2	5	9	8	22
Total		10	20	16	46

Experiment 4 PD task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	1	3	3	7
	1	2	4	2	8
	2	4	6	7	17
	Total	7	13	12	32

Experiment 4 ND task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	0	2	2
	1	1	2	4	7
	2	4	8	11	23
	Total	5	10	17	32

Experiment 5 no experience task

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	0	2	1	0	3
	2	0	0	2	1	0	3
	3	0	0	2	3	3	8
	4	0	0	1	4	6	11
	Total	0	0	7	9	9	25

Experiment 5 verbal experience task

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	1	2	0	1	4
	2	0	0	3	3	0	6
	3	0	0	2	4	4	10
	4	0	1	1	1	2	5
Total		0	2	8	8	7	25

Experiment 5 self experience task

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	0	0	0	1	1
	2	0	1	0	1	0	2
	3	0	0	0	5	1	6
	4	1	1	1	10	3	16
Total		1	2	1	16	5	25

Experiment 5 combined experience task

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	1	0	0	2	3
	2	0	1	1	2	1	5
	3	0	1	2	6	2	11
	4	0	1	0	1	4	6
	Total	0	4	3	9	9	25

Experiment 6 no experience task (5-year-olds)

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	0	0	1	0	1
	2	0	1	3	1	0	5
	3	0	1	3	2	1	7
	4	0	0	2	3	5	10
Total		0	2	8	7	6	23

Experiment 6 verbal experience task (5-year-olds)

		Correct number of feeling trials					
		0	1	2	3	4	Total
Correct number of looking trials	0	0	1	0	0	1	2
	1	0	0	1	0	1	2
	2	0	3	2	2	1	8
	3	3	0	3	1	1	8
	4	0	0	0	1	0	1
	Total	3	4	6	4	4	21

Experiment 6 relevant experience task (5-year-olds)

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	1	1
	1	0	2	1	1	0	4
	2	0	4	3	2	0	9
	3	0	0	1	0	1	2
	4	0	0	0	1	3	4
Total		0	6	5	4	5	20

Experiment 6 no experience task (6-year-olds)

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	0	0	2	0	2
	2	0	0	0	1	1	2
	3	0	1	0	0	2	3
	4	0	0	2	2	6	10
Total		0	1	2	5	9	17

Experiment 6 verbal experience task (6-year-olds)

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	0	0	0
	1	0	0	0	1	0	1
	2	0	1	2	0	0	3
	3	0	0	2	3	2	7
	4	0	0	1	2	3	6
	Total	0	1	5	6	5	17

Experiment 6 relevant experience task (6-year-olds)

		Correct number of feeling trials					Total
		0	1	2	3	4	
Correct number of looking trials	0	0	0	0	1	0	1
	1	0	0	2	0	1	3
	2	0	0	2	0	0	2
	3	0	0	0	1	0	1
	4	0	1	1	2	7	11
	Total	0	1	5	4	8	18

Experiment 7 aspect question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	1	0	1
	1	0	4	3	7
	2	1	3	8	12
Total		1	8	11	20

Experiment 7 dimension question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	0	1	0	1
	1	2	6	1	9
	2	2	4	4	10
Total		4	11	5	20

Experiment 7 identity question task

		Correct number of feeling trials			Total
		0	1	2	
Correct number of looking trials	0	1	5	1	7
	1	3	2	2	7
	2	5	0	1	6
Total		9	7	4	20

REFERENCES

Apperly, I. A., & Robinson, E. J. (1998). Children's mental representations of referential relations. *Cognition, 67*, 287-309.

Apperly, I. A., & Robinson, E. J. (2002). Five-year-olds' handling of reference and description in the domains of language and mental representation. *Journal of Experimental Child Psychology*, *83,* 53-75.

Astington, J.W., & Pelletier, J. (1996). The language of the mind: Its role in teaching and learning. In D. R. Olson & N. Torrance (Eds.), *Handbook of Education and Human Development: New Models of Learning, Teaching, and Schooling*. (pp. 593-619). Oxford: Blackwell.

Astington, J. W., Pelletier, J., & Homer, B. (2002). Theory of mind and epistemological development: The relation between children's second-order false-belief understanding and their ability to reason about evidence. *New Ideas in Psychology*, *20*, 131-144.

Bacharach, V. R., Carr, T. H., & Mehner, D. S. (1976). Interactive and independent contributions of verbal descriptions to children's picture memory. *Journal of Experimental Child Psychology*, *22*, 492-498.

Baddeley, A. D. (1986). *Working memory.* Oxford: Oxford University Press.

Beck, S. R., & Robinson, E. J. (2001). Children's ability to make tentative interpretations of ambiguous messages. *Journal of Experimental Child Psychology*, *79*, 95-114.

Belke, E. (2006). Visual determinants of preferred adjective order. *Visual Cognition*, *14*(3), 261-294.

Burr, J. E., & Hofer, B. K. (2002). Personal epistemology and theory of mind: Deciphering young children's beliefs about knowledge and knowing. *New Ideas in Psychology*, *20*, 199-224.

Clements, W. A., & Perner, J. (1994). Implicit understanding of belief. *Cognitive Development, 9*, 377-397.

Conroy, R., & Salmon, K. (2006). Talking about parts of a past experience: The impact of discussion style and event structure on memory for discussed and non-discussed information. *Journal of Experimental Child Psychology, 95,* 278297.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in integrating information between and within sentences. *Journal of Experimental Psychology: Learning, Memory and Cognition, 9*, 561–584.

Donaldson, M. (1978). *Children's Minds*. London: Fontana.

Dretske, F. I. (1969). *Seeing and Knowing*. Chicago: University of Chicago Press.

Eberhard, K. M., Spivey-Knowlton, M. J., Sedivy, J. C., & Tanenhaus, M. K. (1995). Eye movements as a window to real-time spoken language comprehension in natural contexts. *Journal of Psycholinguistic Research*, *24*, 409-436.

Elischberger, H. B., & Roebers, C. M. (2001). Improving young children's free narratives about an observed event: The effects of nonspecific verbal prompts. *International Journal of Behavioral Development, 25*(2), 160-166.

Esbensen, B. M., Taylor, M., & Stoess, C. (1997). Children's behavioural understanding of knowledge acquisition. *Cognitive Development*, *12*, 53-84.

Fay, A. L., & Klahr, D. (1996). Knowing about guessing and guessing about knowing: Preschoolers' understanding of indeterminacy. *Child Development*, *67*(2), 689-716.

Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), *The Nature of Intelligence* (pp.231-236). Hillsdale, NJ: Erlbaum

Flavell, J. H. (1979). Meta-cognition and cognitive monitoring: A new area of cognitive-developmental enquiry. *American Psychologist*, *34*(10), 906-911.

Flavell, J. H. (2000). Development of children's knowledge about the mental world. *International Journal of Behavioral Development*, *24*(1), 15-23.

Flavell, J. H., Green, F. L., & Flavell, E. R. (1989). The development of children's knowledge about attentional focus. *Developmental Psychology*, *31*(4), 706-712.

Friedman, O., Griffin, R., Brownell, H., & Winner, E. (2003). Problems with the seeing = knowing rule. *Developmental Science, 5*(6), 505-513.

Garnham, W. A., & Ruffman, T. (2001). Doesn't see, doesn't know: Is anticipatory looking really related to understanding of belief? *Developmental Science*, *4*(1), 94-100.

Gobbo, C., Mega, C., & Pipe, M.-E. (2002). Does the nature of the experience influence suggestibility? A study of children's event memory. *Journal of Experimental Child Psychology*, *81*, 502-530.

Goldin-Meadow, S., Nusbaum, H., Garber, P., & Church, R. (1993). Transitions in learning: Evidence for simultaneously activated strategies. *Journal of Experimental Psychology: Human Perception and Performance, 19*(1), 92-107.

Gopnik, A., & Astington, J. (1988). Children’s understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development, 59,* 26-37.

Gopnik, A., & Graf, P. (1988). Knowing how you know: Young children’s ability to identify and remember the sources of their beliefs. *Child Development, 59,* 1366-1371.

Haider, H., & Frensch, P. A. (1999). Information reduction during skill acquisition: The influence of task instruction. *Journal of Experimental Psychology: Applied*, *5*(2), 129-151.

Hogrefe, G. J., Wimmer, H., & Perner, J. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. *Child Development*, *57*, 567-582.

Johnson, C. N., & Wellman, H. M. (1980). Children’s developing understanding of mental verbs: Remember, know and guess. *Child Development*, *51*(4), 1095-1102.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review*, *99*, 122–149.

Kemps, E., De Rammelaere, S., & Desmet, T. (2000). The development of working memory: Exploring the complementarity of two models. *Journal of Experimental Child Psychology, 77*(2), 89-109.

Logan, G. D. (1975). On the relation between identifying and locating masked targets in visual search. *Quarterly Journal of Experimental Psychology*, *27*, 451-457.

Martin, J. E. (1969). Semantic determinants of preferred adjective ordering. *Journal of Verbal Learning and Verbal Behavior*, *8*, 697-704.

Martin, J. E., & Molfese, D. L. (1972). Preferred adjective ordering in very young children. *Journal of Verbal Learning and Verbal Behavior*, *11*, 287-292.

Marvin, R. S., Greenberg, M. T., & Mossler, D. G. (1976). The early development of conceptual perspective taking: Distinguishing among multiple perspectives. *Child Development*, *47*(2), 511-514.

McGuigan, F., & Salmon, K. (2005). Pre-event discussion and recall of a novel event: How are children best prepared? *Journal of Experimental Child Psychology*, *91*, 342–366.

Miscione, J. L., Marvin, R. S., O'Brien, R. G., & Greenberg, M. T. (1978). A developmental study of preschool children's understanding of the words "know" and "guess". *Child Development, 49*(4), 1107-1113.

Moore, C., Bryant, D., & Furrow, D. (1989). Mental terms and development of certainty. *Child Development*, *60*(1), 167-171.

Murachver, T., Pipe, M.-E., Gordon, R., Owens, J. L., & Fivush, R. (1996). Do, show, and tell: Children's event memories acquired through direct experience, observation, and stories. *Child Development, 67*, 3029–3044.

Naito, M. (2003). The relationship between theory of mind and episodic memory: Evidence for the development of autonoetic consciousness. *Journal of Experimental Child Psychology*, *85*, 312-336.

O'Neill, D. K., Astington, J. W., & Flavell, J. H. (1992). Young children's understanding of the role that sensory experiences play in knowledge acquisition. *Child Development*, *63*, 474-490.

O'Neill, D. K., & Chong, S. C. F. (2001). Preschool children's difficulty understanding the types of information obtained through the five senses. *Child Development*, *72*(3), 803-815.

O'Neill, D. K., & Gopnik, A. (1991). Young children's ability to identify the sources of their beliefs. *Developmental Psychology*, *27*(3), 390-397.

Olson, D. R. (1970). Language and thought: Aspects of a cognitive theory of semantics. *Psychological Review*, *77*, 257-273.

Onishi, K. H., & Baillargeon, R. (2005). Do 15-month-old infants understand false beliefs? *Science, 8*, 255-258.

Perner, J. (1990). Experiential awareness and children's episodic memory. In: W. Schneider and F.E. Weinert, (Eds), *Interactions among aptitudes, strategies, and knowledge in cognitive performance*, (pp. 3–11), New York: Springer-Verlag.

Perner, J. (1991). *Understanding the Representational Mind*. London: MIT Press.

Perner, J. (2000). Dual control and the causal theory of action. In N. Eilan & J. Roessler (Eds.). *Agency and Self-awareness*. Oxford: Oxford University Press.

Perner, J., Kloo, D., & Gornik, E. (2007). Episodic memory development: Theory of mind is part of re-experiencing experienced events. *Infant and Child Development*, *16*, 471-490.

Perner, J., Kloo, D., & Stottinger, E. (2007). Introspection and remembering. *Synthese*, *159*, 253-270.

Perner, J., Leekham, S., & Wimmer, H. (1987). Three-year-olds' difficulty with false belief: The cause for a conceptual deficit. *British Journal of Developmental Psychology*, *5*, 125-137.

Perner, J., & Ruffman, T. (1995). Episodic memory and autonoetic consciousness: Developmental evidence and a theory of childhood amnesia. *Journal of Experimental Child Psychology, 59*, 516-548.

Piaget, J. (1941). *The Child's Conception of Number*. London: Routledge & Kegan Paul.

Piaget, J., & Inhelder, B. (1956). *The Child's Conception of Space*. London: Routledge.

Pillow, B. H. (1989). Early understanding of perception as a source of knowledge. *Journal of Experimental Child Psychology*, *47*, 116-129.

Pillow, B. H. (1993). Preschool children's understanding of the relationship between modality of perceptual access and knowledge of perceptual properties. *British Journal of Developmental Psychology*, *11*, 371-389.

Pillow, B. H., & Anderson, K. L. (2006). Children's awareness of their own certainty and understanding of deduction and guessing. *British Journal of Developmental Psychology*, *24*, 823-849.

Pillow, B. H., Hill, V., Boyce, A., & Stein, C. (2000). Understanding inference as a source of knowledge: Children's ability to evaluate the certainty of deduction, perception, and guessing. *Developmental Psychology*, *36*(2), 169-179.

Pratt, C., & Bryant, P. (1990). Young children understand that looking leads to knowing (so long as they are looking into a single barrel). *Child Development*, *61*(4), 973-982.

Robinson, E. J., Champion, H., & Mitchell, P. (1999). Children's ability to infer utterance veracity from speaker informedness. *Developmental Psychology*, *35*(2), 535-546.

Robinson, E. J., Haigh, S. N., & Nurmsoo, E. (2008). Children's working understanding of knowledge sources: Confidence in knowledge gained from testimony. *Cognitive Development*, *23*, 105-118.

Robinson, E. J., Haigh, S. N., & Pendle, J. E. C. (2008). Children's working understanding of the knowledge gained from seeing and feeling. *Developmental Science*, *11*(2), 299-305.

Robinson, E. J., & Robinson, W. P. (1982). Knowing when you don't know enough: Children's judgements about ambiguous information. *Cognition, 12*, 267-280.

Robinson, E. J., Thomas, G. V., Parton, A., & Nye, R. (1997). Children's overestimation of the knowledge to be gained from seeing. *British Journal of Developmental Psychology, 15*(3), 257-273.

Robinson, E. J., & Whitcombe, E. L. (2003). Children's suggestibility in relation to their understanding about sources of knowledge. *Child Development, 74*(1), 4862.

Sagi, D., & Julesz, B. (1985). "Where" and "what" in vision. *Science, 228*(4704), 1217-1219.

Scaife, M., & Bruner, J. S. (1975). The capacity for joint visual attention in the infant. *Nature, 253*, 265–266.

Siegal, M. (1991). *Knowing Children: Experiments in Conversation and Cognition*. Hove, UK: Erlbaum.

Siegal, M., & Surian, L. (2004). Conceptual development and conversational understanding. *Trends in Cognitive Science, 8*(12), 534-538.

Smith, L. B., Jones, S. S., & Landau, B. (1992). Count nouns, adjectives, and perceptual properties in children's novel word interpretations. *Developmental Psychology, 28*(2), 273-286.

Sodian, B., & Wimmer, H. (1987). Children's understanding of inference as a source of knowledge. *Child Development, 58,* 424-433.

Sophian, C., & Wellman, H. M. (1980). Selective information use in the development of search behavior. *Developmental Psychology, 16*(4), 323-331.

Sutherland, R., Pipe, M., Schick, K., Murray, J., & Gobbo, C. (2003) Knowing in advance: The impact of prior event information on memory and event knowledge. *Journal of Experimental Child Psychology, 84,* 244-263.

Tardif, T., Wellman, H. M., Fung, K. Y. F., Liu, D., & Fang, F. (2005). Preschoolers' understanding of knowing-that and knowing-how in the United States and Hong Kong. *Developmental Psychology, 41*(3), 562-573.

Taylor, M. (1988). Conceptual perspective taking: Children's ability to distinguish what they know from what they see. *Child Development, 59,* 703-718.

Tulving, E. (1983). *Elements of Episodic Memory*. New York: Oxford University Press.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology, 26*, 1–12.

Varouxaki, A., Freeman, N. H., Peters, D., & Lewis, C. (1999). Inference neglect and ignorance denial. *British Journal of Developmental Psychology, 17*, 483-499.

Wellman, H. M. (1990). *The Child's Theory of Mind*. Cambridge, MA: Bradford Books/MIT Press.

Whitcombe, E. L., & Robinson, E. J. (2000). Children's decisions about what to believe and their ability to report the source of their belief. *Cognitive Development, 15*, 329-346.

Wimmer, H., Hogrefe, G.-J., & Perner, J. (1988). Children's understanding of informational access as a source of knowledge. *Child Development, 59*, 386-396.

Wimmer, H., Hogrefe, G.-J., & Sodian, B. (1988). A second stage in children's conception of mental life: Understanding informational accesses as origins of knowledge and belief. In J. W. Astington, P. L. Harris, and D. R. Olson (Eds.), *Developing theories of mind*, (pp.173-192). New York: Cambridge University Press.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*, 103-128.

Woolley, J. D., & Wellman, H. M. (1993). Origin and truth: Young children's understanding of imaginary mental representations. *Child Development, 64*, 1–17.